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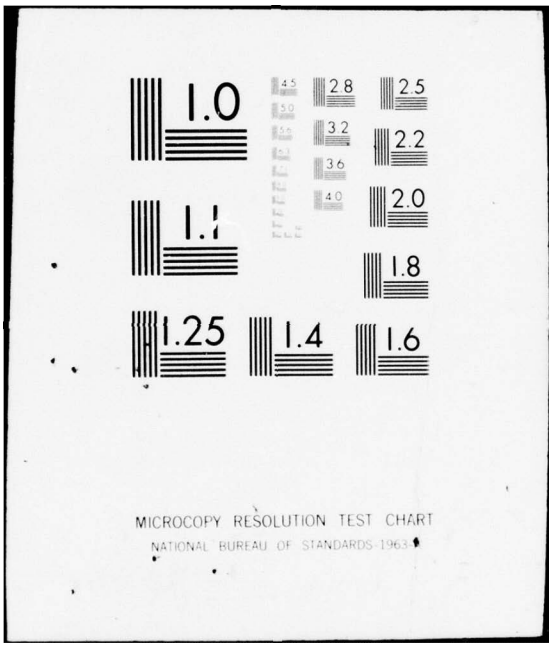
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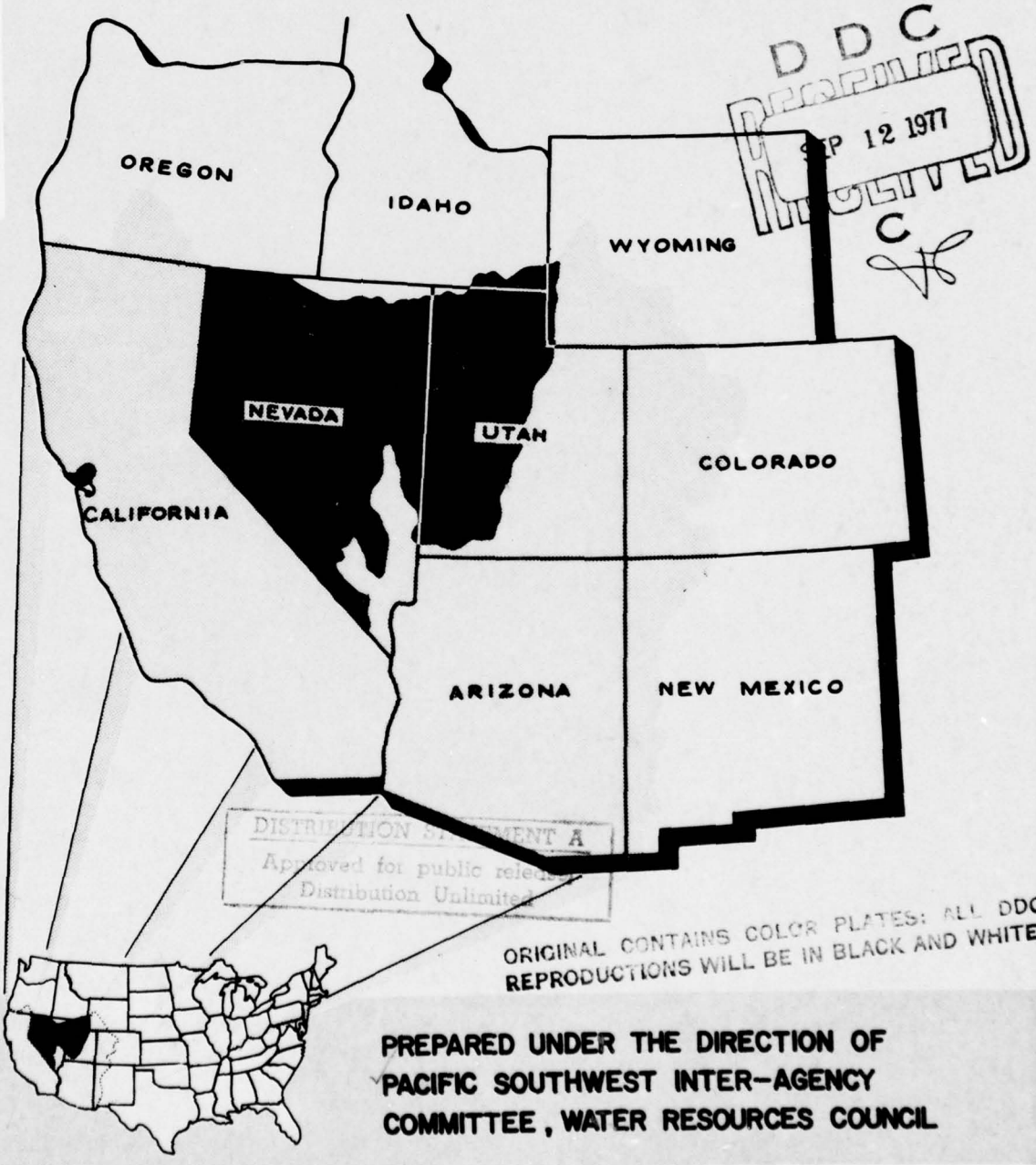
MAIN REPORT

GREAT BASIN REGION

COMPREHENSIVE FRAMEWORK STUDY



PREPARED UNDER THE DIRECTION OF
PACIFIC SOUTHWEST INTER-AGENCY
COMMITTEE, WATER RESOURCES COUNCIL

MAIN REPORT

This report was prepared by the Great Basin Staff of the Great Basin Region State-Federal Interagency Group.

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GREAT BASIN REGION

COMPREHENSIVE FRAMEWORK STUDY

MAIN REPORT

(11) JUNE 1971

(12) 82 p.

The following publications have been prepared under the Great Basin Region Comprehensive Framework Study:

Main Report
Appendixes

I	History of Study
II	The Region
III	Legal and Institutional Environments
IV	Economic Base and Projections
V	Water Resources
VI	Land Resources and Use
VII	Mineral Resources
VIII	Watershed Management
IX	Flood Control
X	Irrigation and Drainage
XI	Municipal and Industrial Water
XII	Recreation
XIII	Fish and Wildlife
XIV	Electric Power
XV	Water Quality, Pollution Control and Health Factors
XVI	Shoreline Protection and Development (not applicable)
XVII	Navigation (not applicable)
XVIII	General Program and Alternatives

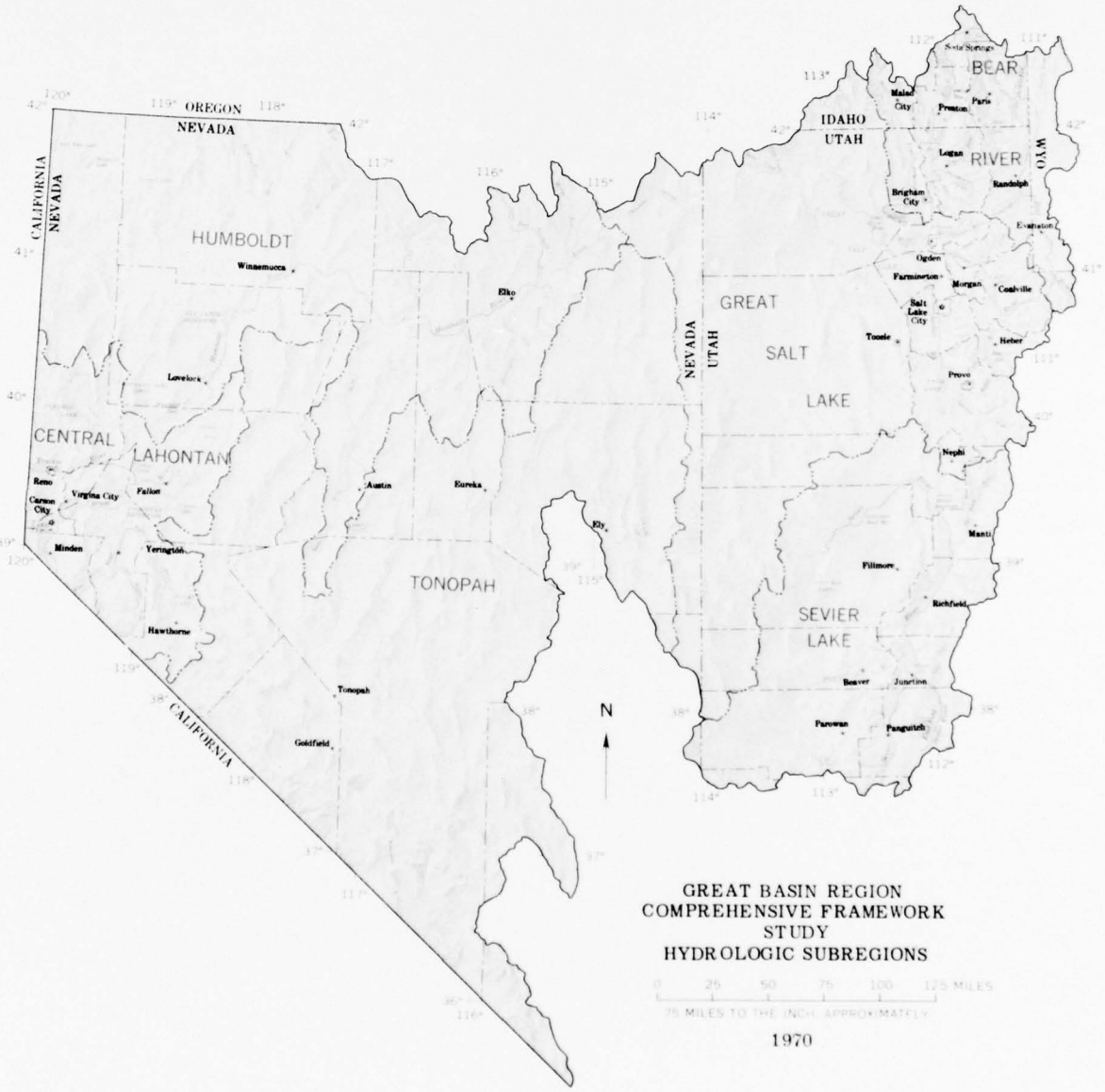
FOREWORD

This report of the Great Basin Region State-Federal Interagency Group was prepared at field level and presents a framework program for the development and management of the water and related land resources of the Great Basin Region. This report is subject to review by the interested federal agencies at the departmental level, by the Governors of the affected states, and by the Water Resources Council prior to its transmittal to the Congress for its consideration.

This report is prepared in accordance with guidelines, objectives and projections set forth by the Water Resources Council which is directing a national effort toward regional comprehensive framework planning. It includes the main report and 16 supporting appendixes. Estimated requirements for water and related land resources within the Region are based on an assigned portion of a set of national projections of March 1968 developed by the Office of Business Economics, U.S. Department of Commerce and Economic Research Service, U.S. Department of Agriculture. This study evaluates the adequacy of water and related land resources in the Great Basin Region to meet these projected requirements through selected time frames to 2020. The resultant program considered with framework plans of the other Regions, permits a general evaluation of the national capacity to meet projected requirements for water and related land resources for the next 50 years.

The plan represents a concept--an illustration of one way to meet the coming needs and the kinds of problems that are involved. Developments of specific projects under this or other comprehensive plans would require more detailed studies. The plan does not necessarily reflect the programs or viewpoints of any federal or state agency.

The several states are currently in various stages of preparation of state water plans. The completed state water plans undoubtedly could reflect significant differences from this framework plan due to differences in projections and their translation into the needs for water and related land resources.



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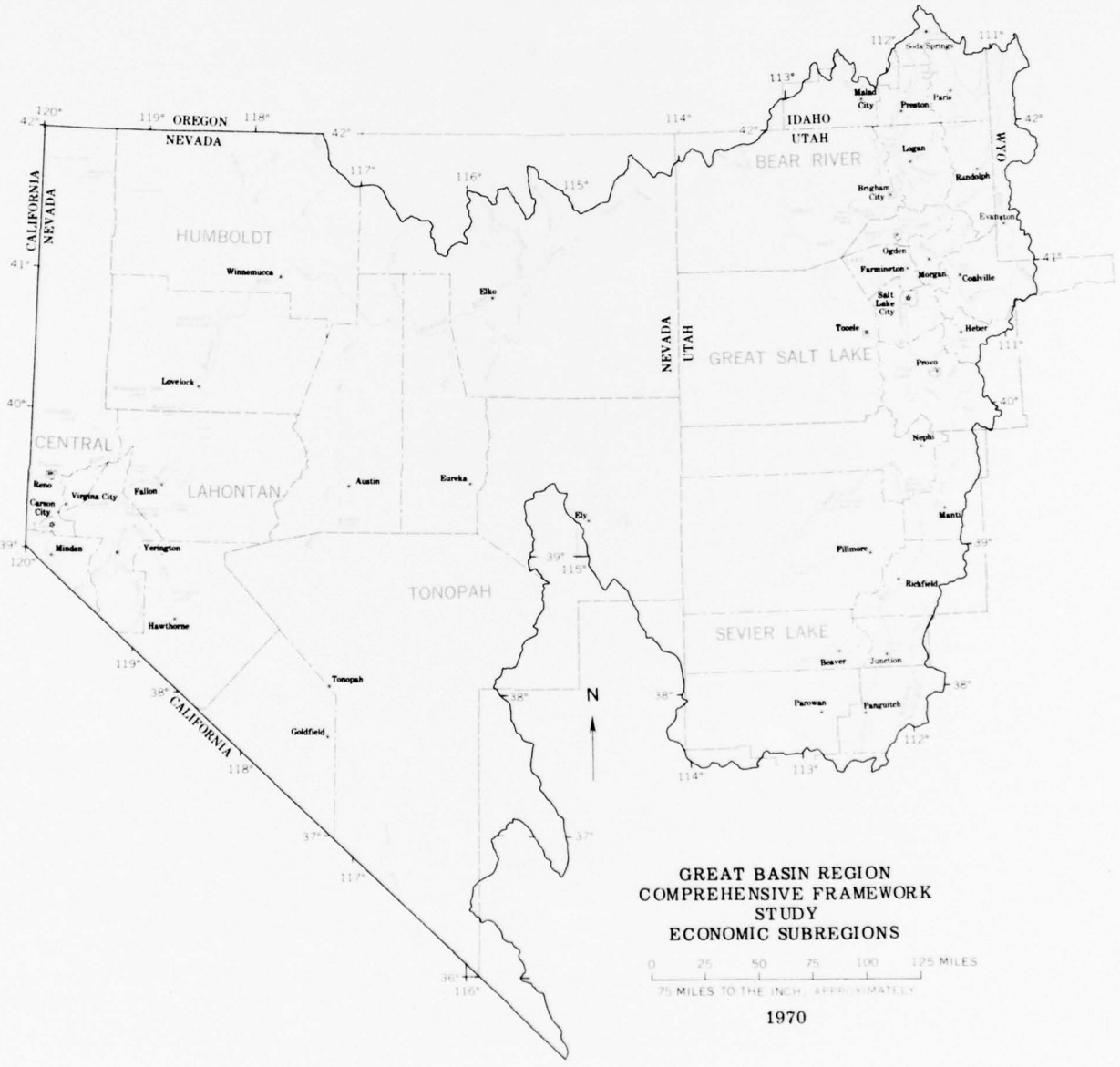

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SUMMARY

Under the direction of the Water Resources Council and the Pacific Southwest Inter-Agency Committee, the Great Basin Region State-Federal Interagency Group organized and directed this comprehensive framework study. The study is an assessment of the ability of the Region to meet the needs of assumed projected levels of population growth and economic development. Present uses are identified and available resources compared with estimated needs to the year 2020.

The Region comprises approximately 136,700 square miles covering most of Nevada, about half of Utah, and lesser parts of Idaho and Wyoming. Elevations range from 2,100 feet to over 13,000 feet. The climate varies widely but is generally semiarid. Precipitation varies from 3 to 5 inches in the southern deserts to about 60 inches in the high mountains, averaging about 11 inches annually. Average annual temperatures range from 60°F in the south to 30°F in high mountain valleys. The relative humidity is generally low, winds are light to moderate, and sunshine is abundant. Average frost-free periods range from 100 to 175 days in the major agricultural areas.

The Region is characterized by north-south trending parallel mountain ranges separated by broad desert basins. Lacking access to the sea, landlocked lakes once covered large areas. Ancient shorelines, beach features, and lake remnants are prominent features.

The total nominal surface-water supply is about 10 MAF (million acre-feet). Total ground water in storage in the upper 100 feet of saturated material is about 200 MAF. While estimates of stored ground-water appear large, the amount that can be practicably withdrawn from any given area is limited by quality, distribution and location. Annual withdrawals and depletions in 1965 were 8.7 and 6.0 MAF, respectively, primarily for agriculture.

The soils principally comprise the shallow mountain soils, the variable mountain valley soils, and the deep valley floor soils. Vegetal cover consists of limited alpine areas, more extensive forested areas, and vast range and barren areas.

Most of the population is located along the eastern boundary of the Region and along the western border of Nevada.

Regional Economy

Future needs and economic levels of development have been established by OBE-ERS (Office of Business Economics and Economic Research Service) projections. The population is projected to increase from

1.2 million in 1965 to 3.2 million in 2020. Total employment would increase from 0.4 million to 1.3 million for the same period. Total personal income would increase from about $3 billion to over $40 billion in 2020 and gross regional product from $3.3 billion to $50 billion.

Projected agricultural production consists principally of livestock feeds and meat production. The harvest from an additional 65,000 acres of irrigated land would be required.

Water and Related Resource Requirements

Annual water withdrawals would increase about 2.3 MAF and depletions 1.5 MAF by 2020. Irrigated agriculture would remain the predominant use through 2020, although municipal and industrial use would require the largest increase in supply.

Recreation and related land uses show the greatest increase followed by urban and commercial uses. Agricultural uses, principally grazing, would decrease about 2 million acres. Conversion of cropland principally to municipal and industrial use would require development of 245,000 acres of new irrigated land.

Watershed land treatment and management measures would be required on 40 million acres by 2020. About 12 million acres would require intensive treatment measures.

Mineral production is expected to increase from $389 million annually in 1965 to $630 million by 2020. Mineral production is governed by national, rather than regional, requirements.

Flood damages exceeded $5 million in 1965. With planned flood protection facilities and measures, projected damages in 2020 would be reduced from $24 million to $7.8 million annually.

Total annual outdoor recreation demands would increase from 31 million recreation-days in 1965 to 350 million in 2020. Water-based recreation demands would increase from 41,000 to 230,000 surface acres in the same period.

Electric power requirements would increase from 5,500 gigawatt hours in 1965 to 160,000 gigawatt hours annually in 2020. Nuclear plants would replace most imports in the last time frame.

Development Program

Water is the limiting factor in development of the Region. The undeveloped supply is consumed by vegetation in shallow ground-water areas and evaporation from terminal sinks. Development consists principally of authorized imports or converting water from one use to another of higher economic value.

To meet the projected water requirements, streamflow diversions would increase from about 7.6 to 8.9 MAF, ground-water diversions from about 1.0 to 1.7 MAF, and imports from 0.1 to 0.2 MAF. In addition, desalting of residual flows to Great Salt Lake or additional imports of 0.1 MAF would be developed.

Total regulated surface-water storage would increase from 4.3 to 7.6 MAF. Most municipal and industrial return flows would be treated to permit reuse.

There is adequate land to meet projected requirements, but competition between uses would increase. Required watershed treatment and management measures would be applied on the land.

Flood control development would provide an additional 1.3 MAF of storage, 310 miles of levees and channels, 725,000 acres of watershed treatment, and flood-plain management programs in 34 urban areas.

Water to maintain terminal lakes was not included as part of the plan, although the economic impact of maintaining Pyramid and Walker lakes is analyzed. If these lakes were to be maintained at their year-end 1965 levels, and the projections met, an additional 270,000 acre-feet would be required in 2020. The upstream water development outlined in the plan would accelerate the rate of decline and deterioration of water quality in these lakes.

Implementation

The States are in various stages of preparing water plans. Framework studies are being used to supplement these plans and provide a base for more detailed planning.

Total cost of the development plan is about $9.1 billion, of which $2.7 billion would be for water development. Total operation, maintenance, and replacement costs would exceed $550 million annually by 2020, about $140 million of this annual cost would be for water development.

The average annual expenditure for present ongoing water development programs is $25 million Federal funds. Average annual water development costs are $32, $23, and $15 million by 1980, 2000 and 2020 respectively.

CONTENTS

PART 1

INTRODUCTION

Study and Authorization

The Great Basin is one of the water resource regions in the United States included in a nationwide program of comprehensive river basin planning for the development, use, and management of water and related land resources. Framework studies are an evaluation, on a broad basis, of the needs for the conservation, development, and utilization of water and related land resources. They identify areas with complex problems which require more detailed investigations. These studies do not include detailed plan formulation involving benefit cost ratios, cost allocations, cost sharing, and repayment analysis. This program is the result of recommendations, from the Senate Select Committee on National Water Resources, which were presented by the President in Fiscal Year 1963 Budget.

The Water Resources Planning Act (P. L. 89-80, July 22, 1965) gave the President authority to organize the Water Resources Council. He transferred the functions and organizational procedure employed by the Interagency Committee on Water Resources to the Water Resources Council on April 10, 1966. This transfer included the Pacific Southwest Interagency Committee (PSIAC). By letter of October 10, 1966, the Water Resources Council requested the PSIAC to take leadership and coordinate the comprehensive studies in the Pacific Southwest, including the Great Basin Region. This leadership responsibility was accepted by letter of November 21, 1966. An organizational meeting was held on May 3, 1968 and funds were made available to begin the Great Basin Region framework study in fiscal year 1969. The States of Utah and Nevada were subsequently designated as chair agencies to direct study efforts.

National Objectives

The basic objective of framework studies is to determine the best use, or combination of uses, of water and related land resources to meet foreseeable needs projected to the year 2020. In pursuit of this basic objective, full consideration is given to development and conservation of resources and the well-being of people.

National economic development, and development of each region within the country, is essential to the maintenance of national strength and achievement of satisfactory levels of living.

Assumptions

Historically, in the west, water has been appropriated for use under State law. It is expected that future uses will be sanctioned under similar jurisdictional arrangements. It is assumed that necessary legal and institutional changes will be made.

Additional water requirements will be satisfied by better utilization of existing supplies through additional storage, salvage, and improved efficiencies, and through authorized imports or desalting of either ocean water made available by exchange or present supplies that have been degraded by use. It is assumed that these water supplies can be made available, however, no cost-benefit analyses were made.

The year 1965 was designated as the base year for the study and all reference to present conditions relate to this date.

Procedure

Appendix XVIII, General Program and Alternatives, generally summarizes the other appendixes, analyzes the resources, needs, and goals, and presents a conceptual plan. This Main Report is essentially a further condensation of Appendix XVIII and the other appendixes. For more detail on plan formulation or a specific subject, the reader is referred to the appropriate appendix.

Constraints

Many constraints were imposed on the study in the interest of collecting as many relevant facts as possible during the limited study period.

Available published and unpublished data were to be used in making the report. Research studies were not permitted to assemble additional data.

Water imports to this Region are limited to those presently being made and to those to be made under authorized projects that may be developed before the year 2020. Water requirements beyond the resources of this Region would be met from additional imports, desalting residual flows, or desalting ocean water.

Present water laws and their interpretation in regard to beneficial use are a constraint to optimum utilization of the present supplies of water. Present water law in Utah disallows mining of ground water. In Nevada, mining of ground water is not illegal. However, the State

Engineer is given authority to prevent depletion of a ground-water basin, and it has been the policy of the State Engineer to exercise this authority in such cases. This constraint needs clarification, and in the case of Utah, possible revision.

Economic projections were prepared by the Office of Business Economics (OBE) and the Economic Research Service (ERS). To provide consistency among all of the framework studies in progress in the nation, the Water Resources Council established the 1968 OBE-ERS projections as the basis for estimates of future needs. The Great Basin Study is based on these projections.

Importation of water from outside the Pacific Southwest, except for presently authorized imports, will not be investigated. This constraint is imposed by the Guidelines for Framework Studies.

Participating Agencies

The following list indicates organizations which participated in this study.

California
- Department of Water Resources

Idaho
- Bureau of Mines and Geology
- Department of Fish and Game
- Department of Health and Sanitation
- Department of Parks
- Water Resources Board

Nevada
- Bureau of Environmental Health
- Division of Forestry
- Division of Parks
- Division of Water Resources
- Fish and Game Commission
- State Soil Conservation Committee
- University of Nevada, School of Mines

Utah
- Division of Fish and Game
- Division of Parks and Recreation
- Division of Water Resources
- Geological and Mineralogical Survey
- Office of Attorney General
- State Health Department

Wyoming
- Fish and Game Commission
- Recreation Commission
- State Engineer's Office
- State Health Department

Commissions
- Bear River
- California-Nevada Interstate Compact
- Upper Colorado

Department of Agriculture
- Economic Research Service
- Forest Service
- Soil Conservation Service

Department of Commerce
- National Weather Service, NOAA
- Office of Business Economics

Department of Defense
- Corps of Engineers

Environmental Protection Agency
- Water Quality Office

Department of the Interior
- Bureau of Indian Affairs
- Bureau of Land Management
- Bureau of Mines
- Bureau of Outdoor Recreation
- Bureau of Reclamation
- Bureau of Sport Fisheries and Wildlife
- Geological Survey
- National Park Service
- Office of Regional Solicitor

Federal Power Commission

Coordination and Administration

The Water Resources Council has the responsibility to assure that participation of the member agencies in the comprehensive basin planning program is accomplished in an orderly, efficient, and coordinated manner.

The Great Basin Comprehensive Study is under the general guidance of the Pacific Southwest Inter-Agency Committee, the Coordinated

Planning Subcommittee of PSIAC, and the State-Federal Interagency Group. The State-Federal Interagency Group is cochaired by the States of Utah and Nevada. The Great Basin Staff, composed of State and Federal agency personnel, is responsible for utilizing available data to complete the study.

The Pacific Southwest Inter-Agency Committee has responsibility to coordinate comprehensive planning efforts in the respective States that are included within the Pacific Southwest area. State and Federal representatives on this committee evaluate the effects of potential water resource development on lands and programs administered by them. Each agency provides the basic data, analyses, expertise, and leadership in its special field with full consideration of, and consultation with, other agencies having information and an interest in that field.

The Coordinating Planning Subcommittee reviews data requirements and presentation within reports so that coordination can be realized within the Pacific Southwest Region for the Analytical Summary Report.

The State-Federal Interagency group is composed of representatives of State and Federal agencies within the regional study area. This group reviews working relations with participating members and defines data needs pertaining to the respective comprehensive study.

The Great Basin Staff includes those designated Federal and State representatives that actually make the comprehensive study. They assemble available data and prepare an orderly report of findings. Every effort is made at this level to reach a consensus on pertinent data included in the Great Basin Appendixes and Main Report.

Fifteen work groups are organized and lead agencies designated for each. The lead agency has the prime responsibility for gathering and writing the appendix material with the help of all participating agencies.

The appendixes prepared for the Great Basin Region are listed on the back of the title page. The first three appendixes contain descriptive and background material. The next three appendixes present projections and basic resource data that are used in the remaining appendixes. Water Resources, however, also obtains data from other appendixes as it includes tabulations of present and future water use and requirements as well as basic data.

Appendixes VII through XV, inclusive, deal with a particular type of water and related land development, use, or management. They follow the general procedure of analyzing the present situation, projecting requirements for the target years 1980, 2000 and 2020 based upon the economic projections, and discussing how these requirements can be met.

Appendixes dealing with "Shoreline Protection and Development" and "Navigation" are not applicable in the Great Basin Region.

Appendix XVIII, General Program and Alternatives, presents a summary of the resources, demands, goals, and a framework plan. Alternative means of meeting the demands are also discussed.

The Main Report is a regional summary of data from Appendix XVIII including the framework plan, conclusions, and recommendations. This report includes: (1) a summary of the present status of water and related land development; (2) a summary of the projected requirements; (3) a comprehensive framework plan to meet gross requirements for the time periods 1980, 2000, and 2020; (4) a discussion of the special problems, deficiencies or surpluses of resources; and (5) a discussion of suggested future studies.

The comprehensive framework plan is the coordinated effort of participants from the Federal and State agencies in the Great Basin Region. It does not necessarily reflect the viewpoints of any one agency.

PART II

DESCRIPTION OF REGION

Location and Size

The Great Basin is a 188,000-square-mile area having no outlet to the sea, formed as a great irregular bowl generally centering on Nevada and western Utah. The boundary of this basin is not completely defined by mountain ranges and thus it can be described as that area enclosed, but not drained, by the Colorado River drainage, the Columbia River drainage, and the westward drainage of the Sierra Nevada.

The Great Basin Region excludes those parts of the physiographic basin in Oregon and California. It includes about 80 percent of Nevada, the western half of Utah, a small part of southeastern Idaho, and the southwestern corner of Wyoming. This Region, of approximately 136,700 square miles, has been divided into six hydrologic subregions, as shown on the frontispiece. Figure 1 shows the relationship of this Region to the rest of the contiguous United States. The parts of the Great Basin not included in this Study Region are shown by the outline extending into Oregon and California.

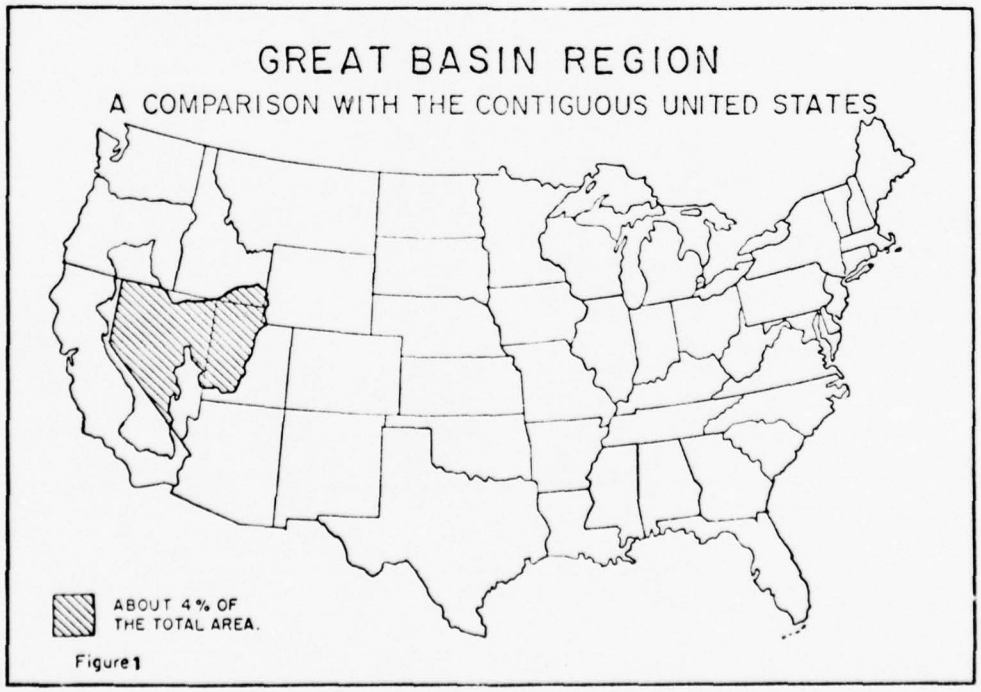


Figure 1. Location Great Basin Region

The Region contains 87.5 million acres of which 85.7 million is land area and 1.8 million is water surface area. Table 1 shows the distribution of land and water area by hydrologic subregions and states.

TABLE 1. DISTRIBUTION OF TOTAL LAND AND WATER AREA BY SUBREGION AND STATE

Hydrologic subregion	Idaho	Nevada	Utah	Wyoming	Great Basin Region Total	Percent
			(1,000 acres)			
Bear River						
Land	1,682	0	2,042	957	4,681	
Water	43	0	50	2	95	
Total	1,725	0	2,092	959	4,776	6
Great Salt Lake						
Land	446	2,438	14,311	5	17,200	
Water	0	0	1,329	0	1,329	
Total	446	2,438	15,640	5	18,529	21
Sevier Lake						
Land	0	70	10,247	0	10,317	
Water	0	0	41	0	41	
Total	0	70	10,288	0	10,358	12
Humboldt						
Land	0	19,104	0	0	19,104	
Water	0	37	0	0	37	
Total	0	19,141	0	0	19,141	22
Central Lahontan						
Land	0	6,059	0	0	6,059	
Water	0	240	0	0	240	
Total	0	6,299	0	0	6,299	7
Tonopah						
Land	0	28,356	0	0	28,356	
Water	0	3	0	0	3	
Total	0	28,359	0	0	28,359	32
Region						
Land	2,128	56,027	26,600	962	85,717	
Water	43	280	1,420	2	1,745	
Total	2,171	56,307	28,020	964	87,462	100
Percent	3	64	32	1	100	

Climate

The climate of the Region varies as a result of the large differences in elevation, an appreciable range in latitude, and the irregular distribution of mountain ranges and highlands. Generally this climate is a semiarid type. Precipitation in the lower valley bottoms ranges from 3 to 5 inches in the rain shadow of the Sierra Nevada and in the Great Salt Lake Desert. In the northern valleys the precipitation is about 15 inches with accumulations up to 60 inches in the higher elevations. Figure 2 shows the general elevation and precipitation relationship across the basin in a west to east direction.

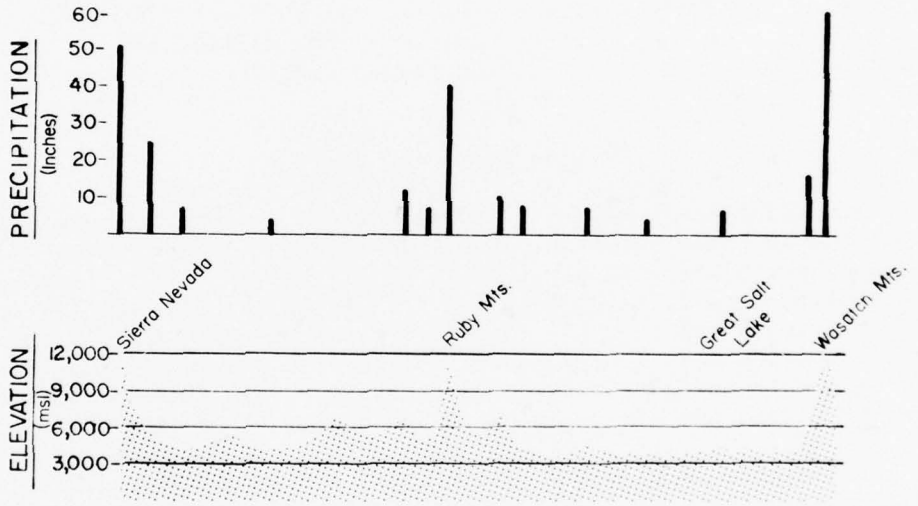


Figure 2. General relationship of elevation and precipitation.

Temperatures are characteristic of arid mountain areas, with definite variations according to elevation and latitude. Average temperatures range from 60°F in the extreme southern part to 30°F in some of the high northern valleys. One of the outstanding features is the wide range between daily maximum and minimum temperatures. Average daily ranges are in excess of 30 degrees over most of the valleys. Variations in excess of 50 degrees are not uncommon in some valleys of western Nevada.

The relative humidity is low, averaging about 35 percent in the north and central sections and dropping to 20 percent in the extreme south. Low humidity, abundant sunshine, and light to moderate winds cause annual evaporation losses exceeding 100 inches in the extreme south and about half that amount in most of the northern and central valleys.

The average frost-free period ranges from about 200 days in the extreme south to less than 20 days above 9,000 feet in the northern mountains. The average in the major agricultural areas ranges between 100 and 175 days.

Sunny skies prevail throughout most of the year, averaging about 75 percent in the south and 70 percent in the north. High pressure cells tend to settle over the area during late fall and winter causing fog to form when the moisture content of the air is high. The average number of days for this condition ranges from 5 to 10 a year.

Land Forms and Geology

The Great Basin Region is characterized by parallel mountain ranges separated by broad desert basins. Most of the mountain ranges trend north to northeast with straight or gently curved crests. Commonly, the ranges are 40 to 80 miles long and 5 to 15 miles wide, and are spaced about 15 to 25 miles apart. Generally, the crests are 3,000 to 5,000 feet above the floors of the adjacent valleys and substantial segments of the crests are more than 9,000 feet above sea level in central and eastern Nevada and along the eastern boundary of the Region in Utah.

The Region is bordered on the east by sedimentary and associated volcanic and intrusive rocks of the Wasatch Range and the high plateaus. The granitic rocks of the Sierra Nevada and spur ranges mark the western border. Thick lava flows along the south side of the Snake River drainage form the northern boundary, and the southern border is made up largely of sedimentary rocks which are dissected by the Colorado River drainage.

The present-day landscape is the result of many geologic processes that have occurred during geologic time. Faulting and folding of great intensity and complexity have occurred. Periods of erosion have subdued highlands and filled lowlands with sediment. These alternating processes of sedimentation, mountain building, and erosion have occurred repeatedly and at various times.

Shoreline and beach features, common in some segments of the basin, were formed by lakes which covered large areas. The largest were Lake Bonneville, which occupied about 20,000 square miles of western Utah; and Lake Lahontan, which occupied more than 8,000 square miles in western Nevada. Great Salt Lake and Utah Lake are present-day remnants of Lake Bonneville, and Pyramid and Walker Lakes are remnants of Lake Lahontan.

Great mineral wealth has been and continues to be extracted from the rocks and saline waters of the Great Basin Region. Unknown, but partly predictable, mineral wealth is concealed beneath the valley floors and in the mountain ranges. The alluvium, which covers more than half the Great Basin area and in some places is several thousand feet thick, is the principal potential source of supply of ground water.

Terminal Lakes

The Great Basin is a group of many hydrologically closed basins, the drainage of which terminates in lakes or sinks. Some of these lakes are perennial, others dry up occasionally, and others exist only briefly after high runoff periods. Most are isolated remnants of either prehistoric Lake Lahontan or Lake Bonneville.

Any residual streamflow is received in terminal lakes or sinks from which the water is finally evaporated. Because of this, terminal lakes become more saline with time since the salts remain as water evaporates. As upstream depletions increase, salinity of the terminal lakes increases and the water levels drop. At the 1965 (base year) level of development an additional 200,000 acre-feet of inflow into Pyramid and Walker lakes would be required to maintain these lakes at their year-end level. Terminal lakes satisfy many uses including fish and wildlife, and recreation.

Water Resources

The Great Basin Region is the most arid of the Comprehensive Framework Study regions. The average annual precipitation is about 11 inches and most of it is consumed in place by vegetation or returned to the atmosphere by evaporation. The total nominal surface water supply, including natural ground-water discharge, is approximately 10 million acre-feet (MAF). This also includes 1.1 MAF inflow from the California Region. Total ground water stored in the upper 100 feet of saturated deposits is in the range of 200 MAF which, if depleted over a period of 50 years, would yield an annual rate of about 4 MAF per year.

The principal rivers of the Region are Bear, Weber, Jordan, and Sevier in the eastern subregions, and Humboldt, Truckee, Carson, and

Walker in the western subregions. These rivers all flow into terminal sinks.

Streamflow is seasonally distributed. Unregulated streams commonly discharge 60 to 80 percent of their annual flow in a 3-month period, starting in April or May. Present total water storage content of lakes, ponds, and reservoirs is approximately 43 MAF. The natural ground-water discharge from 154 separate areas is largely by evapotranspiration in areas of shallow ground water.

Land Resources

The land resources of the Region vary widely in terms of soils, topography, and vegetal cover. The three main classes of soils are the soils of the mountain slopes which are commonly shallow, the mountain valley soils which are extremely variable, and generally deep soils on the valley floors and their adjacent alluvial fans and lake terraces.

The three main types of vegetal cover are alpine, forest, and range. The alpine areas, about 0.3 percent of the land in the Region, are confined to the higher elevations and glaciated basins. Vegetation usually consists of grasses, forbs, and low browse plants. Forested areas, about 20 percent, are usually in the higher mountains. Vegetation varies from coniferous forests to pinyon juniper, which is the most common type. Range areas, about 70 percent, occupy the vast interior basins. Vegetation consists mainly of northern desert shrub and salt desert shrub with small areas of grasses and forbs. The remaining 10 percent of the land in the Region consists of barren, urban, and commercial areas including irrigated and dry cropland.

The land resources in the Region would be suitable for increased development if water were available. Thus, the water resource is a restraint on more intensive utilization of much of the land resource.

Mineral Resources

The Region contains vast mineral resources, both known and predictable by geologic environment, which can be developed as economic climate and demands will permit.

In 1965, metals accounted for nearly 85 percent of the total mineral production, nonmetallic minerals about 15 percent, and fuels less than 1 percent. Copper comprised over half of the value of all mineral output, and molybdenum, gold, iron ore, and sand and gravel were the next four in value of commodities produced. The Region is also one of the leading areas in the United States in the production of

lead, silver, mercury, barite, diatomite, magnesite, and phosphate rock. Lake brine is receiving increased attention as a source of mineral production.

Geothermal Resources

There is considerable evidence of vast geothermal potential. Recent studies show that about 35 percent of the known geothermal resource areas in the United States are located in this Region.

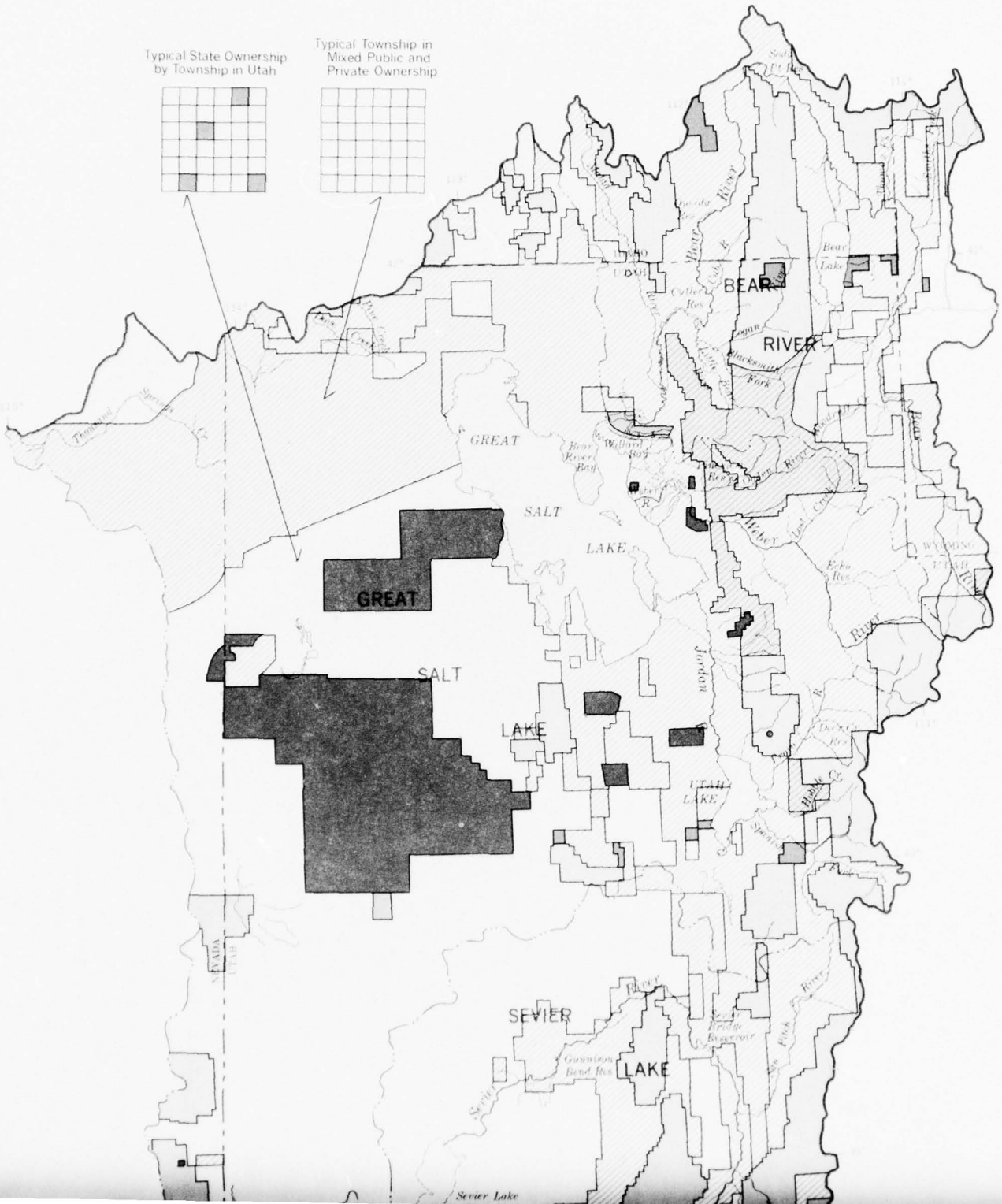
Land Ownership and Administration

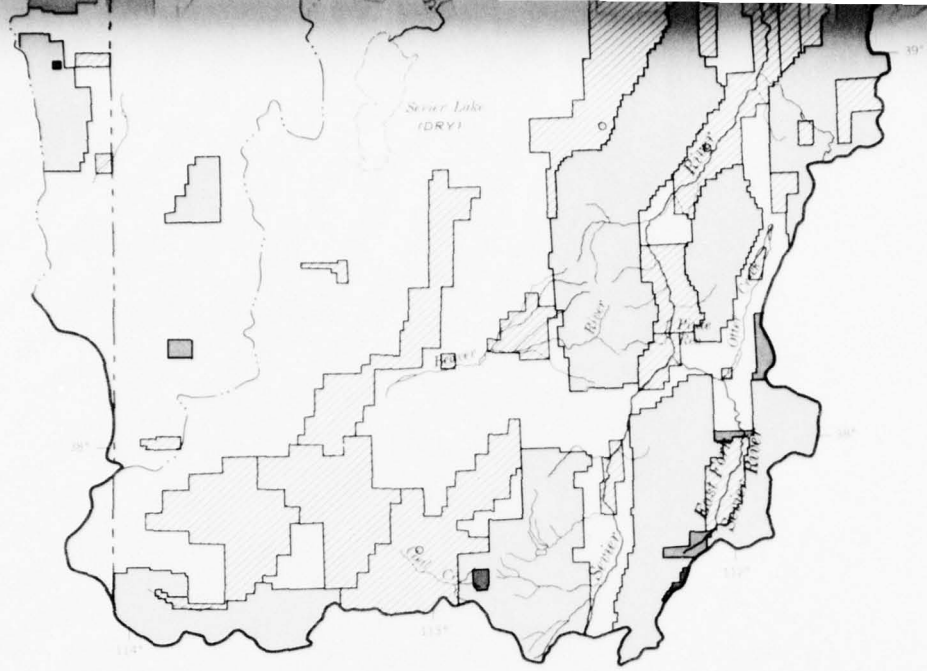
Approximately 76 percent of the total land area of the Region is administered by the Federal Government, and 24 percent is in State, county, municipal, and private ownership. The maps following page 13 show land ownership and administration of the Region.

Federally administered lands comprise 83 percent of the land area in Nevada, 62 percent in Utah, 60 percent in Wyoming, and 42 percent in Idaho. These lands include large military installations in Nevada and Utah.

Private land is scattered throughout the Region, generally in the fertile valleys where water exists. These are generally concentrated along major river systems near the base of the Sierra Nevada in the west and the Wasatch Mountains in the east. A checkerboard pattern of private and public land ownership extends across the northern part of the Region due to railroad land grants.

Upon admission to statehood, various amounts of land were provided to the States in aid of education. Different policies of land management were used in administering these lands. Nevada and Utah represent the extremes with Nevada having disposed of virtually all of its grant land, while Utah still retains virtually all its original grants. Nevada, however, received much less land than did Utah. Over 97 percent of State administered land is in the eastern subregions and less than 3 percent is in the western subregions.


Typical State Ownership by Township in Utah
Typical Township in Mixed Public and Private Ownership
BEAR
RIVER
GREAT
SALT
LAKE
GREAT
SALT
LAKE
SEVIER
LAKE
UTAH
LAKE
NEVADA
UTAH
Sevier Lake



EXPLANATION

FEDERAL ADMINISTRATION

- Bureau of Land Management
- National Forest
- National Park Service
- Department of Defense (includes A.E.C.)
- Fish and Wildlife Refuge

INTERMINGLED

- Bureau of Land Management and Private
- National Forest and Private

PRIVATE OWNERSHIP

- Private, Municipal, County and other
- Indian Reservations

STATE OWNERSHIP

- State
- Larger Lakes
- Boundary of hydrologic subregions

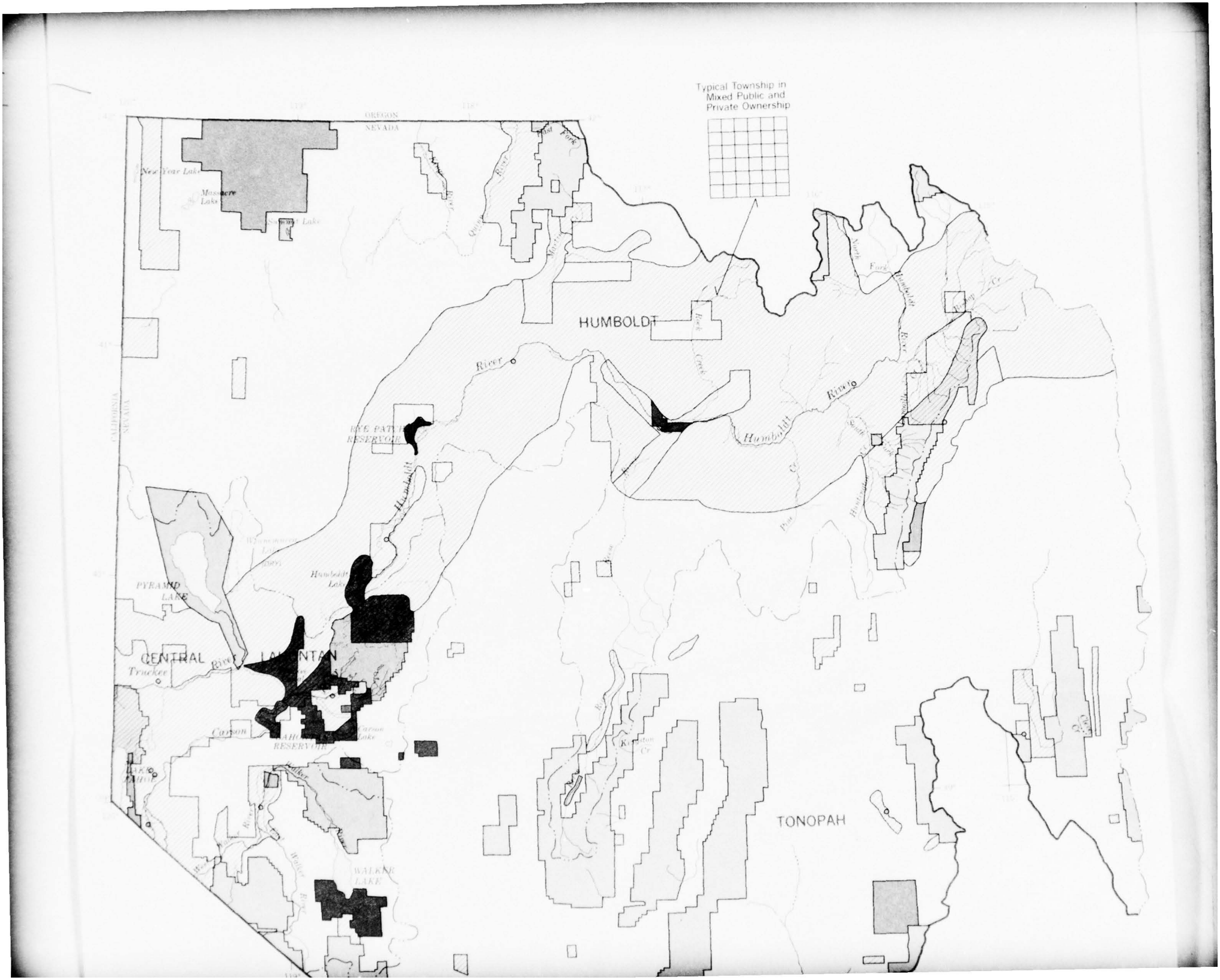
GREAT BASIN REGION
COMPREHENSIVE FRAMEWORK
STUDY
(EASTERN SUBREGIONS)

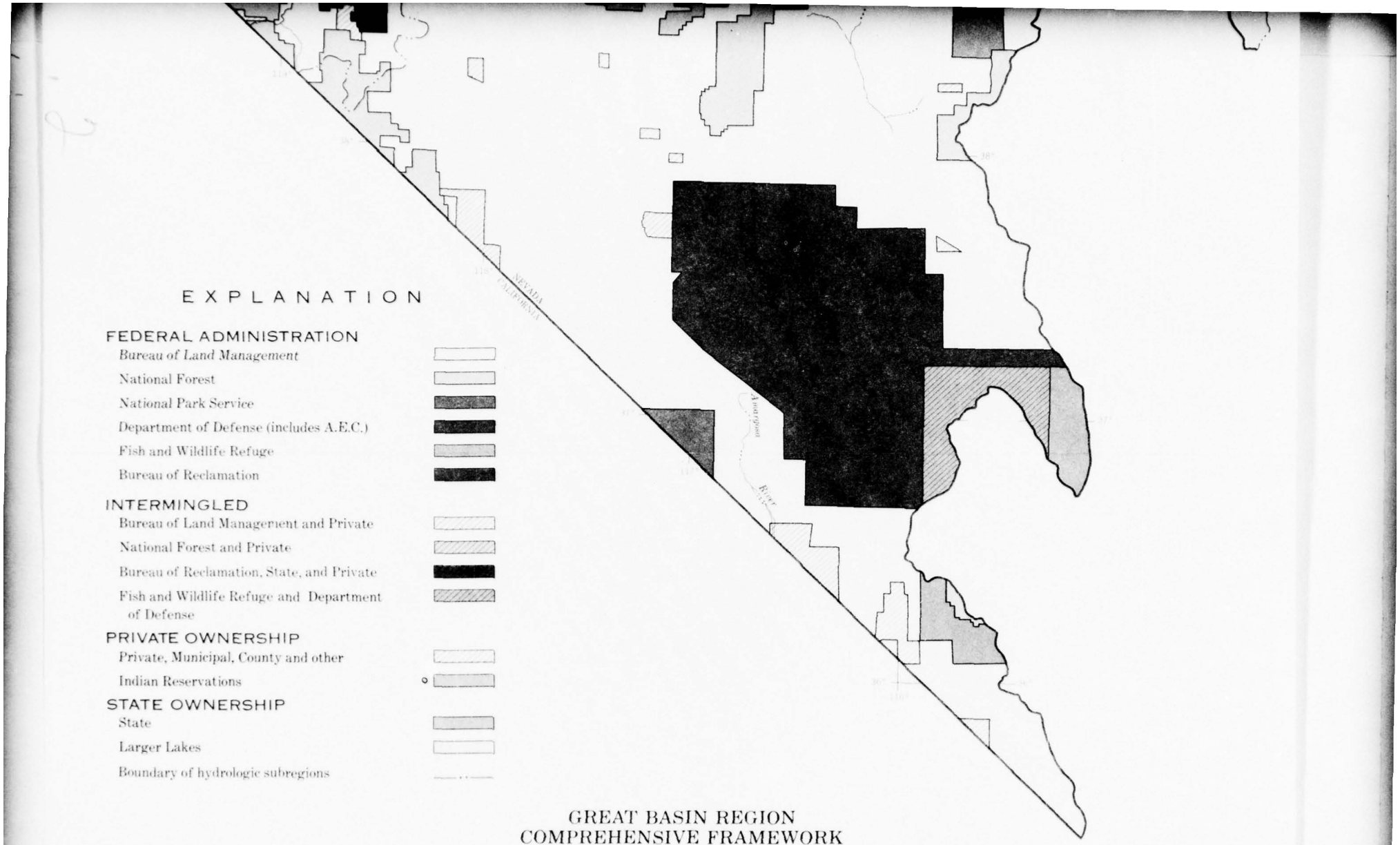
0 25 50 75 MILES

32 MILES TO THE INCH, APPROXIMATELY

1970

GENERALIZED LAND OWNERSHIP AND ADMINISTRATION STATUS AS OF 1965


Typical Township in Mixed Public and Private Ownership
OREGON
NEVADA
CALIFORNIA
NEVADA
New Year Lake
Massacre Lake
Summit Lake
HUMBOLDT
Humboldt River
Rock Creek
North Fork Humboldt River
RYE PATCH RESERVOIR
PYRAMID LAKE
Truckee River
CENTRAL
LAHONTAN
Carson River
Carson Lake
Walker River
WALKER LAKE
TONOPAH



GENERALIZED LAND OWNERSHIP AND ADMINISTRATION STATUS AS OF 1965

Population - Distribution and Density

The Region's population is concentrated in two major areas. These are the Wasatch Front in Utah and the Reno-Carson-Tahoe area in Nevada. Four counties, which make up the major part of the Wasatch Front area, contain about 65 percent of the population, and the Reno-Carson-Tahoe area comprises about 11 percent. Figure 3 shows the location of the population centers in the Region.

Figure 3. Population centers - 1960

PART III

REGIONAL ECONOMY

This section contains a description of the economic base of the Region with past, present, and future trends and relationships of the Region to the national economy. The data shown in this section of the report was collected on economic subregion boundaries. The frontispiece maps show the hydrologic and the economic subregions.

Projections

Future needs and levels of development for the Region's economic output have been established under OBE-ERS projections. These projections extrapolate only past trends, and do not provide for possible changes in public attitudes. The agricultural projections reflect national production levels and indexes of regional growth. The term OBE-ERS is applied to all projections obtained in translating these projections into land and water requirements. For the purposes of this report, population projections based on the Bureau of the Census series C rates of increase and the March 1968 economic projections published by the Water Resources Council were used.

General Characteristics and Trends

Population Growth

The Region's population in 1965 was about 1.2 million, compared to 0.5 million in 1930. The overall growth rate was above that for the United States as a whole, but below that of the western states. By 2020, the population is projected to be 3.2 million. Figure 4 shows the past and projected population growth.

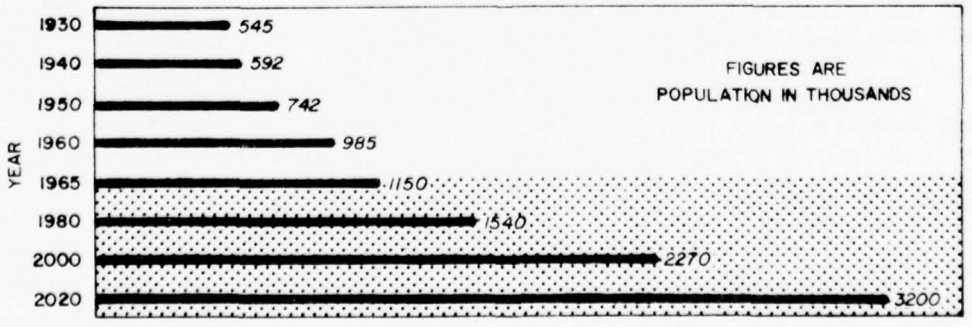


Figure 4. Past and projected population growth - Great Basin Region

Employment

In 1965, State estimates placed total employment in the Region at 416,800 employees, an increase of 142 percent over the 1940 level and 18 percent increase over the employment level of 1960. Employment in 1960 comprised 36 percent of the population. This is comparable to the national average of 37 percent of the population being employed. All major employment categories registered increases during the period 1940-60 except agriculture, forestry and fisheries, and mining. Total employment in the Region is projected to be 1.3 million by 2020.

The OBE projections of employment for the Region, as issued by the Water Resources Council, March 1968, contained estimates for Water Resource Planning areas--the subregions defined by economic boundaries. In this series, projections were made for a few highly aggregated categories. Another source of employment data was available in the form of the OBE projections for the Reno and Salt Lake City economic areas. Employment data projected in greater detail was available for these two areas which are representative of the Region. Figure 5 shows the past and projected employment in selected sectors of the economy.

Gaming employment in 1950 totaled 3,014, which was 7 percent of the western subregions total employment. By 1960, those employed in gaming had increased to 7,542, or 12 percent of the area's total employment. If this trend continues, an even greater percentage of the western subregion employment will be related to the gaming industry.

Personal Income

Personal income is defined as wages and salaries, proprietors' income, property income, pensions, and social security payments. In 1965, personal income in the Region totaled nearly $3 billion.

On a per capita basis, personal income in the Region was below the national level in both 1960 and 1965 when the national per capita income was $2,236 and $2,775, respectively. There has been some reduction in this disparity with an increase from 92.8 percent of the national per capita income level in 1960 to 93.8 percent in 1965.

On a per capita basis, personal income in the eastern subregions is significantly lower and in the western subregions is significantly higher than the national average. Per capita incomes for projected years are shown in the following tabulation.

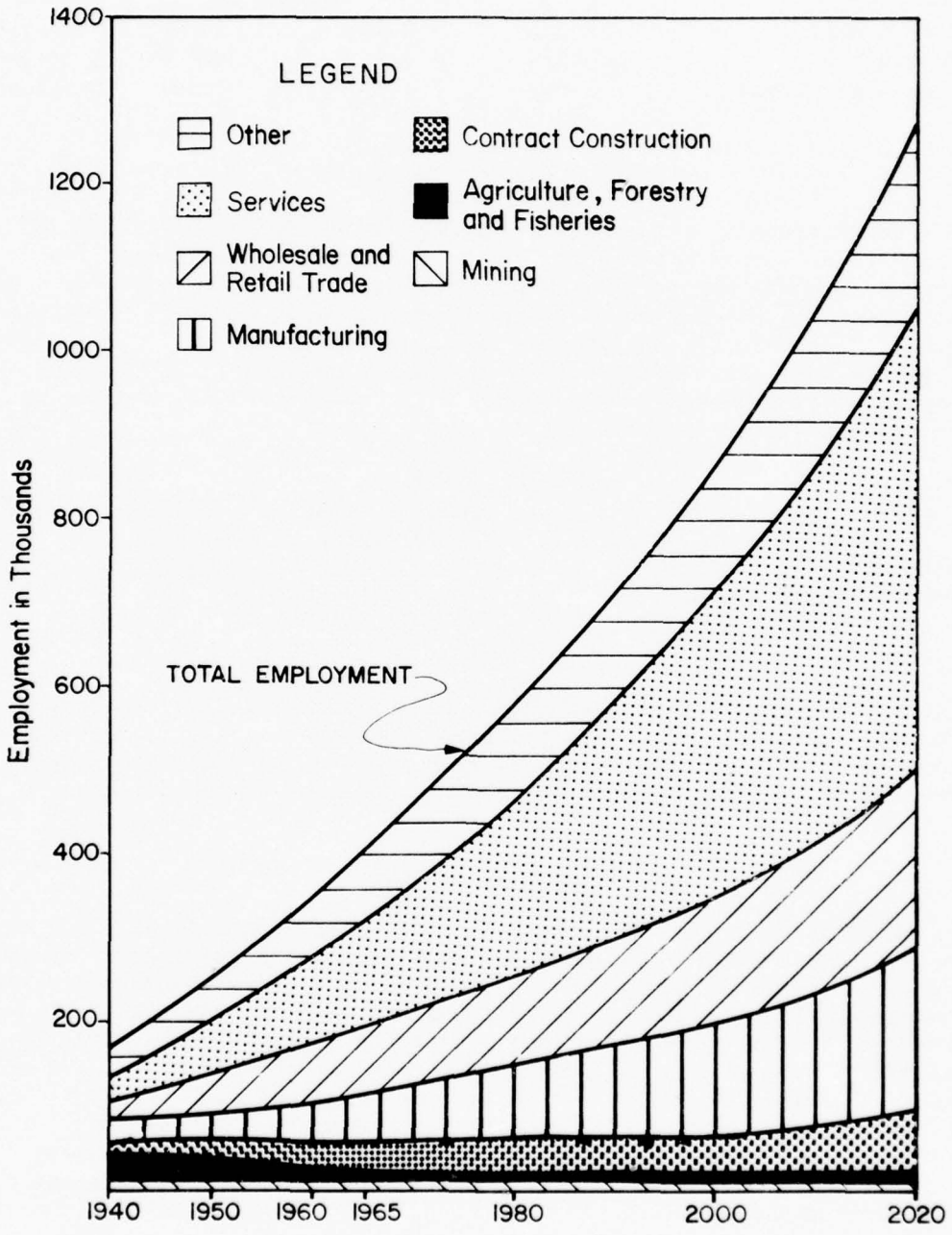


Figure 5. Past and projected employment for selected sectors.

	1965	1980	2000	2020
		(Dollars)		
Eastern half	2,382	3,886	6,959	12,488
Western half	3,576	5,126	8,272	13,448
Regional average	2,602	4,107	7,210	12,680

Gross Regional Product

Gross regional product is defined as local personal consumption expenditures, gross investment, total government expenditures, and exports of goods and services, less imports of goods and services. The gross regional product is a component of the gross national product and thus is a measure of the Region's economic growth and its contribution to the national economic growth. The following tabulation shows a comparison of gross national product with gross regional product for 1965 and projected target dates.

	1965	1980	2000	2020
		(Billions of 1965 dollars)		
Gross national product	617	1,150	2,500	5,300
Gross regional product	3.3	8.4	21	50
Percent regional of national	0.5	0.7	0.8	0.9

A disaggregation of the basic data used to determine the Region's 1965 gross regional product identified the western subregions' portion to be about $700 million which was 22 percent of the Region's total. The eastern subregions contributed 78 percent, or $2,600 million.

Agricultural Economy

Base year (1965) and projected agricultural production, shown on Table 2, represent the Region's share of national requirements for food and fiber. This allocation of food and fiber requirements was distributed among the subregions. It is the base from which agricultural water and land needs were defined and proposed developments were evaluated. Projections of alfalfa seed and cotton production were not included in the OBE-ERS data. These were added and projected to increase at the same rate as alfalfa hay and nationwide cotton production, respectively. Forage requirements for pleasure horses, although not projected by OBE-ERS, are included in the total forage requirements shown.

TABLE 2. AGRICULTURAL PRODUCTION

Commodity	Unit	Great Basin Region 1965[1]	1980	2000	2020
	(1,000)				
Feed grains					
Corn	bu.	120	125	150	165
Oats	bu.	875	920	1,100	1,200
Barley	bu.	7,700	9,500	12,000	17,000
Hay and forage					
Hay	ton	2,118	2,200	2,600	2,900
Silage	ton	517	540	640	710
Pasture[2]	AUM	1,542	2,100	2,300	2,500
Rangeland pasture[2]	AUM	3,966	4,200	5,200	5,800
Seed crops					
Alfalfa seed[2]	cwt.	81	85	100	110
Food crops					
Wheat	bu.	8,238	10,700	12,000	14,000
Vegetables	cwt.	-	2,400	3,100	4,000
Noncitrus fruits	ton	-	40	50	70
Sugar	ton	457	1,300	2,000	2,800
Potatoes	cwt.	1,048	1,500	2,000	2,600
Fiber crops					
Cotton[2]	bl.	5	6	7	8
Cotton seed[2]	ton	12	13	15	18
Meat animals					
Beef and veal	lb.[3]	-	457,000	610,000	800,000
Pork	lb.[3]	-	11,000	15,000	19,000
Lamb and mutton	lb.[3]	-	73,000	97,000	127,000
Poultry products					
Farm chickens	lb.	-	4,700	6,200	8,000
Turkeys	lb.[3]	-	106,000	140,000	180,000
Broilers	lb.[3]	-	6,000	8,000	10,000
Eggs	ea.	185,952	327,000	430,000	560,000
Dairy					
Milk	lb.	737,769	940,000	1,225,000	1,580,000

1/ 1964 Census of Agriculture
2/ Not projected by OBE-ERS
3/ Liveweight

Land needed to produce the food and fiber requirements was determined by projected yields of the various agricultural sectors. Part of these projected yields come from irrigated cropland. Water requirements were determined from the amount of land under irrigation, types of crops grown, and climatic conditions.

Irrigated acreage includes land subjected to crop failure because of water shortage, insect infestation, frost, and other causes. The estimated harvested and total irrigated acreages are shown in the following tabulation.

	1965	1980	2000	2020
		(1,000 acres)		
Harvested acreage				
Eastern subregions	1,010	1,020	1,040	1,080
Western subregions	720	690	710	720
Total	1,730	1,710	1,750	1,800
Irrigated acreage				
Eastern subregions	1,240	1,250	1,270	1,310
Western subregions	760	730	750	760
Total	2,000	1,980	2,020	2,070

The requirements to meet OBE-ERS projections involve an assumption of future crop yields. It is well to realize the sensitivity of such assumptions. For example, if crop yields in 2020 would remain the same as in 1965, although irrigation efficiencies would improve as indicated in the program, the additional requirements by 2020 would be about 1.1 million acres of irrigated land, 4.0 million acre-feet of withdrawals and about 1.9 million acre-feet of depletions.

Industrial and Business Economy

Mining and Minerals

The mining industry played a significant role in the early settlement of the Region. Prospectors in search of heavy metallic minerals began settling widespread areas in the early 1850's. Lack of dependable transportation made the high value gold and silver ores the primary mineral producers. With the advent of rail facilities, copper, lead, and zinc became significant. Iron, molybdenum, and mercury have been important metals in the growth of the Region's mining industry in the last 30 years.

Copper, gold, silver, lead, and zinc have accounted for more than 60 percent of the Region's mineral production from 1864 to 1965. In 1965, the Region produced 13 percent of the total United States metals production. It produced 38 percent of the Nation's gold, 24 percent of the copper, 17 percent of the mercury, 15 percent of the silver, and 13 percent of the lead. Figure 6 shows the total gross value of mineral production.

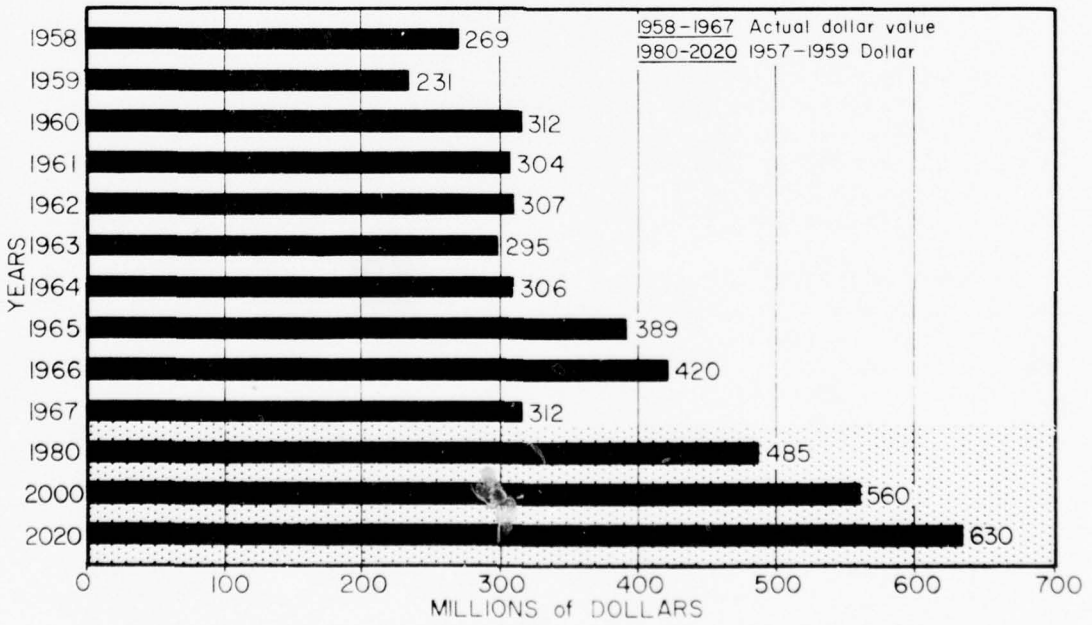


Figure 6. Value of mineral production in the Great Basin Region 1958 through 1967 and projected value to 2020.

Manufacturing

Manufacturing has contributed substantially to the Region's economy. In 1940 there were about 18,000 persons employed in this sector and by 1965 employment was about 58,000. The following tabulation shows the contribution of manufacturing to the economy, expressed in terms of value added.

Year	Value added in millions of dollars
1954	283
1958	427
1963	653
1967	800

Value added is a measure of the cost of producing finished goods and services that go to the final market. It includes wages, salaries, profits, rents, interest, depreciation, and federal, state, and local taxes.

Tourism

Forests, parks, monuments, and recreational areas attract a large number of visitors each year into the Region. In 1965 tourist demand for recreation associated with land and water developments was about 24 million recreation days which was 36 percent of the Region's total recreation demand. By 2020 the demand is expected to be 110 million tourist recreation days, which will be 27 percent of the total demand.

Gaming and other urban attractions were not included in the above demand estimates. In economic terms, gaming, with its adjuncts, is the major recreation industry in Nevada. Total gross expenditures in 1965 far outweighed the sum for all other forms of recreation. Gaming employment for 1965 was 9,600 persons, about 11 percent of total employment, for the Nevada part of the Region.

Recreation

The recreation demand associated with land and water developments in 1965 was about 67 million recreation days. More leisure time, higher incomes and greater mobility have contributed to a rapid increase in recreation demand. Recreation pressures have been exerted within the community areas as well as on far distant wilderness areas. The advent of the snowmobile and other winter sports interests have contributed to this rapid increase.

Fishing and Hunting

In 1965, an estimated 1.8 million man-days of fishing occurred in the Region. The man-days of fishing were distributed among the following: impoundments, 0.8 million man-days; streams, 0.6 million man-days; and natural lakes, 0.4 million man-days. Coldwater fishing accounted for most of this use with about 1.6 million man-days, while warmwater fishing accounted for the remaining man-days.

Sport fishing expenditures were estimated to be $34 million in 1965. Commercial fishing, including brine shrimp fishing in the Great Salt Lake, produced an income of about $0.5 million.

In 1965, there were about 1.3 million man-days of hunting realized in the Region. This hunting activity was distributed among the following: big game, 0.6 million man-days; small game, 0.5 million man-days; and waterfowl, 0.2 million man-days. This hunting activity generated an estimated $35 million in expenditures.

Government

Government employment within the Region in 1940 was about 9,000 compared to 56,000 in 1965. This is an increase of over 500 percent compared to an increase of 94 percent for the total population. Most of this increase was associated with military activities during and following World War II.

In 1940, government employment was about 2,000 in the western subregions and about 7,000 in the eastern subregions. By 1965, government employment in these areas had risen to 12,000 and 44,000, respectively.

PART IV

CURRENT STATUS OF RESOURCE DEVELOPMENT, USE AND PLANNING

This part summarizes the 1965 level of water and related land utilization, management, and development in the Region. The principal uses of water are presented. The present use of the 85.7 million acres of land area is summarized. The development by major functions is briefly discussed.

Water

Present Water Use

On-site depletions of water at the 1965 level of development related to man's activities in the Region were 6.0 million acre-feet. The largest consumptive use was by the 2.0 million acres of irrigated crops, the nonirrigated wet meadows, and reservoir evaporation which is closely associated with irrigation. These three uses consumed 4.7 million acre-feet, or about 78 percent of the total water used in the Region. Managed fish and wildlife areas consumed 734,000 acre-feet, or about 12 percent. Municipal and industrial requirements used 161,000 acre-feet, or about 3 percent; all other managed uses consumed about 36,000 acre-feet, or less than 1 percent of all water used. Unmanaged fish and wildlife and associated wetlands account for the remaining use.

A summary of water withdrawals and depletions for 1965 conditions related to man's activity is shown in table 3.

Surface-Water Development

The surface area and storage capacity of the regulated lakes and reservoirs in the Region are shown in table 4. There is an additional 598,000 acre-feet of storage in California that regulates waters used principally in Nevada. Projects in operation for flood control in 1965 consisted of about 320,000 acre-feet of reservoir storage operated on a flood forecast basis and 23 small flood control reservoirs in watershed areas with a combined storage capacity of about 2,000 acre-feet. The remaining regulated lakes and reservoirs reduce flood damage, although they are not operated specifically for flood control.

TABLE 3. WITHDRAWALS AND DEPLETIONS OF WATER, 1965 LEVEL OF DEVELOPMENT

Type of use	Great Basin Region		
	Eastern subregions	Western subregions	Region
	(1,000 acre-feet annually)		
Withdrawals			
Municipal and industrial	414	79	493
Thermal electric power	5	2	7
Recreation	5	3	8
Minerals	74	22	96
Irrigation	4,609	2,423	7,032
Fish and wildlife	660	357	1,017
Total	5,767	2,886	8,653
Depletions			
Municipal and industrial	134	27	161
Thermal electric power	5	2	7
Recreation	3	3	6
Minerals	10	13	23
Irrigation	1,918	1,015	2,933
Nonirrigated wet meadows	625	495	1,120
Managed fish and wildlife	389	345	734
Unmanaged fish and wildlife and associated wetlands	359	46	405
Reservoir evaporation	540	84	624
Total	3,983	2,030	6,013

Evaporation of 2.3 MAF from terminal lakes is not included.

TABLE 4. ESTIMATED USABLE STORAGE CAPACITY IN UPSTREAM LAKES AND RESERVOIRS, 1965

	Unit	Great Basin Region		
		Eastern subregions	Western subregions	Region
Usable capacity	1,000 AF.	3,332	963 1/	4,295
Surface area	1,000 acres	224	96 2/	320

1/ Includes 240,000 acre-feet of Lake Tahoe which is one-third the active capacity of the lake.

2/ Includes 41,000 acres of Lake Tahoe which is one-third the area of the lake.

Extensive conveyance facilities have been constructed to utilize available water. These vary from transmountain diversions and tunnels, that transfer water between basins, to conveyance systems from small springs and streams. The most extensive diversion and conveyance systems are associated with the major streams, but practically all streams that produce a usable supply are diverted and utilized.

Water developments under construction or presently authorized for construction will import approximately 136,000 acre-feet of additional water into the basin, as well as provide additional storage and regulation of existing water. This water will be used primarily for municipal and industrial purposes in the Great Salt Lake Subregion, but substantial amounts will be available for irrigation by direct diversion, exchanges, and from return flows. Additional water will also accrue for waterfowl habitat use from these return flows.

Extensive on-farm practices that improve water application efficiencies have been applied. However, many areas used to produce native hay or pasture are still irrigated by wild flooding.

Water treatment plants have been constructed within the last 20 years primarily for municipal use. In addition, waste water treatment plants have been constructed to treat municipal and industrial return flows to reclaim this water for other uses.

Historically, industrial firms using small quantities of water have been supplied from public systems. Industries using large amounts of water, on the other hand, have developed independent water systems by diverting directly from streams, lakes, springs, or wells.

Most of the water development for fish and wildlife purposes is associated with reservoirs constructed principally for other uses, and with development and management of waterfowl habitat near the terminal lakes or sinks of the major streams.

Lakes and reservoirs in the Region have provided a significant contribution to the resource supply required to meet water-based recreation demand.

Water development associated with electric power generation, in recent years, has been primarily to provide cooling water for fossil-fueled thermal plants. Most of the small hydroplants constructed near the turn of the century were phased out as they became obsolete, while more recent plants continue to operate.

PART IV

CURRENT STATUS OF RESOURCE DEVELOPMENT, USE AND PLANNING

Ground-Water Development

Ground-water withdrawal by wells in 1965 was estimated to be about 1 million acre-feet. About 760,000 acre-feet were withdrawn in the eastern part of the Region from 55 ground-water areas, and 280,000 acre-feet in Nevada from 178 ground-water areas.

Approximately 2,000 pumped wells have accounted for most of the withdrawals from wells in the Region for a number of years. Individual yield rates of these wells are as great as 8,600 gpm (gallons per minute) and the specific capacity may be as great as 3,000 gpm per foot of drawdown. The average pumping rate, however, is about 1,000 gpm and the average specific capacity is about 43 gpm per foot of drawdown.

The large withdrawals along the eastern margin of the Region are typically in well-watered areas and ground-water levels fluctuate from year to year but remain relatively stable over the long term. However, concentrated pumping causes localized overdrafts. Similar conditions exist in the Central Lahontan Subregion and in several valleys in the Humboldt Subregion. In the drier parts of the Region, some ground-water pumpage is from storage. Consequently, water levels will decline for many years before relative equilibrium will be reached.

Present Water Quality

The upstream surface waters generally have excellent quality; however, the water deteriorates as it moves downstream, increasing in salt concentration from natural sources, from irrigation return flows, and from other uses. Sediment pollution occurs on many streams during periods of flooding.

Excessive concentrations of nutrients exist in some streams in the Region. The nutrients are derived mainly from municipal sewage treatment plant effluents, septic tank infiltration, and some undetermined contribution from irrigation.

Total coliform counts in streams occasionally exceed acceptable standards for public water supplies. The effluent from food processing plants and municipal waste treatment plants is a major source of bacteriological pollution and is known to cause large increases of bacterial concentrations in some streams.

Generally, in areas of natural recharge, the ground water is fresh; in areas of natural discharge in the vicinity of terminal lakes and sinks, the ground water is commonly saline to briny (1,000 to 35,000 mg/l). Saline water also occurs locally in the vicinity of thermal springs and in areas where the aquifer system includes rocks that

contain large amounts of soluble salts. In any valley with no outlet, the lowest point becomes the site of a terminal sink or playa. Here, natural salts are concentrated by evaporation and locally saline ground water is usually present.

The chemical quality of ground water varies considerably with depth. In most places, there is a progressive increase in dissolved solids with increasing depth; however, there are exceptions where shallow ground water is more highly mineralized than deep ground water. Ground water having excessive concentrations of fluoride occurs in many areas, especially in the domestic supplies of smaller towns. Arsenic, boron, and other minor constituents occur in ground water, especially in the Tonopah Subregion.

Land

Present Land Uses

A summary of the 1965 land uses is shown in table 5. Multiple use occurs simultaneously on much of the land, whereas exclusive use occurs on other land. Watershed management and production of certain wildlife species are compatible with good range management. Grazing can occur on some recreational and timber lands without adverse effects. Uses, such as military, minerals, urban and industrial, and transportation and utilities are primarily exclusive.

Land developed for mineral extraction occupies about 421,000 acres in the Region. Because of intensive development, these lands are generally exclusive of other uses. There were 74 mineral products produced in the United States in 1965 and 32 of these were produced in the Region.

TABLE 5. PRESENT LAND USE, 1965

Principal use[1/]	Great Basin Region		
	Eastern subregions	Western subregions	Region
	(1,000 acres)		
Irrigated cropland	1,327	787	2,114
Nonirrigated cropland	1,083	0	1,083
Grazing land	23,697	39,541	63,238
Timber	2,243	109	2,352
Urban and industrial	201	164	365
Outdoor recreation	209	221	430
Wilderness and scenic	60	69	129
Flood control measures	26	6	32
Military and related	1,861	3,101	4,962
Minerals	207	214	421
Fish and wildlife	398	1,658	2,056
Classified watershed	255	97	352
Transportation and utilities	303	308	611
Water control reservoirs	224	96	320

1/ Does not include all land or all uses. Multiple uses of land are made in most categories.

The Region's forested lands total 13 million acres, including large pinyon-juniper areas. Commercial timber stands occupy only 2.4 million acres and only a small part is classified as usable saw timber. Watershed protection for water production is of major importance on these lands. Other compatible uses are wildlife habitat, livestock forage production, and recreation which includes camping, fishing, hunting, and picnicking.

Livestock grazing is one of the most extensive uses of land in the Region. About 74 percent of the land area is used for this purpose. Grazing takes place at a wide range of elevations, from 2,500 to 11,000 feet. Precipitation varies with elevation and latitude, ranging from 4 to over 50 inches annually. Forage availability, season, and intensity of use vary with these extreme differences. High mountain areas offer the best summer ranges while the low desert lands are more suited to winter grazing. About 83 percent of the forage requirements for sheep and 16 percent of the requirements for cattle are derived from range forage.

The Region's cultivated land occupies about 1 million acres of nonirrigated cropland and 2 million acres of irrigated cropland. Nonirrigated cropland is limited to suitable areas in the eastern part of the Region. Additionally, there are an estimated 895,000 acres of nonirrigated wet meadowland managed for agricultural use. These

nonirrigated wet meadowlands are generally interspersed and managed with irrigated cropland and pasture.

Nonirrigated cropland is used principally for production of small grains with some production of alfalfa and alfalfa seed. About 75 percent of the irrigated land is used to produce hay and pasture, 14 percent to produce small grains and silage, 4 percent to produce row crops, and 6 percent remains idle. The nonirrigated wet meadowlands are used principally for pasture with some hay production.

Land areas occupied exclusively for flood control projects totaled about 7,000 acres in 1965. In addition to 322,000 acre-feet of reservoir storage, flood control developments included 48 miles of levee, 70 miles of channel improvement, and about 24,000 acres of land treatment in watershed areas. Average annual flood damages still exceeded $5.3 million in 1965. These damages amount to $2.2 million in upstream areas and $3.1 million in downstream areas.

Settlement of the Region and establishment of towns and cities and related industries occurred where water was most abundant. Consequently, most of the development was along the Wasatch Front in Utah and along the eastern slope of the Sierra in Nevada. Urban and industrial development was principally in the valley areas adjacent to irrigated land. As population increased, irrigated cropland converted to urban and industrial use. At the present time, the economy of these population centers has shifted from an agricultural to an industrial base.

Hunting and other wildlife activities are of great significance in the Region. A variety of wildlife exists in esthetically appealing forest, range, and marsh habitat. Extensive areas of national forest and public domain make much of the potential hunting opportunity available to the general public. The concentration of the Region's human population into a few limited areas has helped to maintain large expanses of wildlife habitat in a near natural condition. This enhances the area for hunters and other outdoor enthusiasts.

The most desirable resources are located along the Region's perimeter as is the Region's population. The location of urban recreation developments appears to be influenced more by patterns and problems of urban growth than by resource availability. However, in this Region, tourism significantly influences the total recreation demand and the types of resources required to satisfy this demand. Outdoor recreation demand in the Region totaled 67 million recreation-days in 1965. Water-based recreation demand was approximately 30 percent of this total.

PART IV

CURRENT STATUS OF RESOURCE DEVELOPMENT, USE AND PLANNING

During the past 25 years, electric power generation in the Region has shifted from predominantly hydroelectric to thermal-electric as demands have increased. The Region required about 5,500 million kwh in 1965. About 3,000 million kwh was imported from adjacent regions. Major land uses have been for site location and transmission line rights-of-way.

Other Development

The Region is traversed by major highways, both east to west and north to south. It is served by four major railroads and several airlines. The Wasatch Front in Utah, the Reno-Carson-Tahoe area, and communities along the Humboldt River in Nevada are served by natural gas pipelines.

The largest single use of land besides grazing is for military and related purposes. These include supply and test centers in western Utah and the Atomic Test Center in southern Nevada.

State Water Planning

Each of the four States in the Region is in the process of preparing a State water plan.

The Idaho Water Resources Board is responsible for the preparation of the State of Idaho Water Plan, which is scheduled to be completed in the late 1970's. Basic data and information on the water and related land resources of the State are being provided by a series of water needs studies. Type I Framework Studies are being used as a base for formulation, and other water related studies in Idaho will also be utilized.

The State of Nevada, Division of Water Resources, under the direction of the State Engineer, is now preparing a State Water Plan. This plan is utilizing the Type I Studies as well as contracting with various State and Federal agencies and private firms to supplement the work done by the planning staff. The plan is scheduled to be completed by June 30, 1973.

Preparation of Utah's water plan is under the direction of the Division of Water Resources. Work of the planning staff is being augmented by Federal and State agencies as well as by private consultants. Four possible development alternatives, as well as a program of action, have been included in an interim report. This report has been submitted to the 1971 Legislature.

PART IV

CURRENT STATUS OF RESOURCE DEVELOPMENT, USE AND PLANNING

In July 1967, Wyoming initiated its water planning program under the direction of the State Engineer's office. Wyoming is utilizing a basin-by-basin approach with an inventory stage followed by an analysis of alternative ways of development. The planning staff will utilize programs with State, Federal, and private entities to provide additional information to assist in formulation of a State water plan. The plan is tentatively scheduled for completion in 1972.

A compact between California and Nevada has been prepared which will apportion water between the two States in the Lake Tahoe, Truckee River, Carson River, and Walker River drainage basins. Both States' Legislatures have approved the compact and it has been submitted to the Congress of the United States for ratification. Compact negotiations on apportionment of Bear River water between Idaho, Utah and Wyoming are in progress. These compacts will complete apportionment of interstate streamflows affecting the Region.

Effect on the Environment

Three primary factors, elevation, latitude, and physiography, provide the basis for most of this Region's diversity. The environmental diversity is also shown in the wide variety of living forms in the Region.

During the first 100 years of man's history in the Region, the predominant forces influencing the face of the land were probably domestic livestock grazing, irrigation, timbering, and mining. During the past 20 years, man has begun to modify the environment by utilization of arable lands for nonagricultural purposes. These include extension of roads and trails into the more remote areas; pollution of water, air, and land; construction of massive water control devices; and environmental disruption by mining activities. Even with this disruption, the total environment is generally stable, but care is needed to maintain and to enhance it.

Open space is an important part of the Region's environment. Population growth is causing urban sprawl, pollution problems, and the beginning of the many urban ills which now face the nation's larger cities. A program to preserve open space would help resolve future land use conflicts and preserve or improve the total environmental quality.

Since the Region has no outlet to the sea, the water originating in or imported to the basin is consumed. Before man's development, the water was consumed by native vegetation and by evaporation from terminal lakes, sinks, and wetlands. Man's development and use of water generally constituted only a change in use. This change has caused

reduced inflow to the terminal lakes, sinks, and wetlands. The most pronounced effect is the historical decline of the terminal lakes. Even if no further upstream uses occurred, the effect of man's past activity would cause further declines in the lake levels. Reduced inflows caused by man's activity has caused salinity to increase. Salinity is approaching concentrations where fishlife may be endangered.

Storage reservoirs and diversions have destroyed many of the free flowing streams of the Region and the natural spawning habitat. Fish population is generally maintained by artificial propagation; however, some species are endangered because artificial propagation has not been successful.

Three rare and endangered fish are found only in warm springs and pools in western and southern Nevada. Their habitat is endangered by possible lowering of ground-water levels. These fish are small with no direct value for food or sport but are of considerable scientific value and interest. They are believed to be living remnants of the Pleistocene age and provide examples of evolution and adaption to changing environment.

The Utah prairie dog, which is found in parts of southern Utah, is endangered because of predator control practices.

The bowl-shaped characteristics of the valleys in the Region are conducive to temperature inversions. Critical air pollution problems have developed where population centers are concentrated in these valleys.

The early settlers of the Region were not prepared for the rigorous task of living in this arid or semiarid environment. They had little knowledge to guide them in the use and conservation of available resources. Indiscriminate grazing, farming, mining, timber harvest, and other developments destroyed most of the native watershed conditions. Spectacular and devastating flash floods resulted. These occurred principally along the steep eastern and western rims of the basin where man's activities were greatest. Much of the Region's desirable vegetation has been replaced by plants with limited forage and watershed value, and many critical areas remain bare and erodible. However, since the 1930's, much has been done to restore many areas and implement better management practices. In many steeply sloping areas in the higher precipitation zones and in the desert areas with very low precipitation, restoration may never be possible.

PART V

WATER AND RELATED RESOURCES AVAILABILITY

Water Resources

The degree to which water is available for use is limited by occurrence, physical conditions, laws, administrative or institutional regulations, customs, patterns of use, purpose of use, and economics. Availability depends on the set of limitations selected.

The estimated average annual precipitation in the Region is 11.3 inches. This produces 82 MAF of water on the 87.5 million acres of area. Most of this water is consumed in place by vegetation or evaporated from ground and water surfaces. Only about 10 percent becomes available as surface and ground-water flow. Table 6 lists the estimated annual renewable water supply available under present conditions.

TABLE 6. ESTIMATED ANNUAL WATER SUPPLY

Source	Great Basin Region		
	Eastern subregions	Western subregions	Region
	(1,000 acre-feet)		
Estimated average annual runoff	4,818	1,252	6,070
Natural ground-water discharge	998	1,264	2,262
River inflow from other regions 1/	0	1,120	1,120
Net imports 2/	98	0	98
Total supply	5,914	3,636	9,550

1/ From California Region.
2/ From Upper and Lower Colorado Regions.

Only about 1.6 MAF of the estimated average annual runoff is measured at the maximum flow gaging stations on the principal rivers in the Region. Natural ground-water discharge is largely by evapotranspiration in shallow-ground-water areas.

River inflow is by natural flow from the California Region to the Central Lahontan Subregion. This will reduce somewhat as additional uses occur in California.

Imports are made by transregion diversions. About 95,000 acre-feet of water is from the Upper Colorado Region to the Great Salt Lake Subregion and the remainder is from the Lower Colorado Region to the Sevier Lake Subregion.

Natural storage in ground-water reservoirs and storage in lakes and reservoirs contain large volumes of water. The quantities available in 1965 are shown in table 7.

TABLE 7. GROUND-WATER, LAKE, AND RESERVOIR STORAGE, 1965

Source	Great Basin Region		
	Eastern subregions	Western subregions	Region
	(1,000 acre-feet)		
Ground-water reservoirs[1/]	84,000	110,000	194,000
Lakes and reservoirs	18,000[2/]	25,000[3/]	43,000
Total	102,000	135,000	237,000

1/ Estimated amount in the upper 100 feet of saturated deposits.
2/ Includes 10.6 MAF in Great Salt Lake.
3/ Includes 23.6 MAF in Pyramid and Walker Lakes. There is an estimated 40.0 MAF in the Nevada part of Lake Tahoe that is not included.

Most of this supply is available on a one-time use basis only. The storage in the terminal lakes is currently declining and, to meet projected needs, the rate of decline is expected to increase. One-time ground-water reserves could provide about 4 MAF annually for a 50-year period. These supplies may require treatment, depending on the use.

Land Resources

Of the 85.7 million acres of land in the Region, about 12.4 million are suitable and available for irrigation. About 1.9 million acres are suitable and available for dry cropland; all in the eastern subregions. The dry cropland is also included in that suitable for irrigation. About 2.4 million acres are suitable for timber production. About 64.2 million acres, including suitable cropland, are suitable for grazing. The general suitability of the land for agricultural purposes is shown on the maps following page 35. Suitability is based on climate and the physical characteristics of the land. Suitability does not consider the present use of the land and certain areas are not available. That part of the land where the climate is such that small grains could be grown economically on a crop and fallow system, without irrigation, is considered as suitable for dry farming. Land suitable for timber


BEAR
RIVER
Bear Lake
Cutler Res
Oneida Res
Malad
Little Bear River
Bear River Bay
Willard Bay
Ogden River
Weber
Echo Res
Woodruff Cr
GREAT SALT LAKE
GREAT
SALT
LAKE
Military withdrawal
Jordan R
UTAH LAKE
Spanish Fork
Deer Cr Res
SEVIER
LAKE
Sevier River
Gunnison Bend Res
Sevier Bridge Reservoir
San Pitch River
IDAHO
UTAH
NEVADA
UTAH
WYOMING
UTAH
Thousand Springs Cr
Pole Creek
42°
41°
40°
39°
111°
112°
113°
114°
115°

EXPLANATION

Suitable for irrigation and grazing. At least 50 percent of area is arable

Suitable for irrigation and grazing; area less than 2,000 acres

Suitable for irrigation, dry farming and grazing. At least 50 percent of area is arable

Generally suitable for grazing

Suitable for timber production. At least 50 percent of area generally is suitable for commercial timber

Suitable for timber production and grazing. At least 50 percent of area generally is suitable for commercial timber

Other land, areas. Includes barren, critical areas, and water surface

Other land; mostly barren; less than 2,000 acres

Military withdrawal boundary

Boundary of hydrologic subregions

GREAT BASIN REGION
COMPREHENSIVE FRAMEWORK
STUDY
(EASTERN SUBREGIONS)

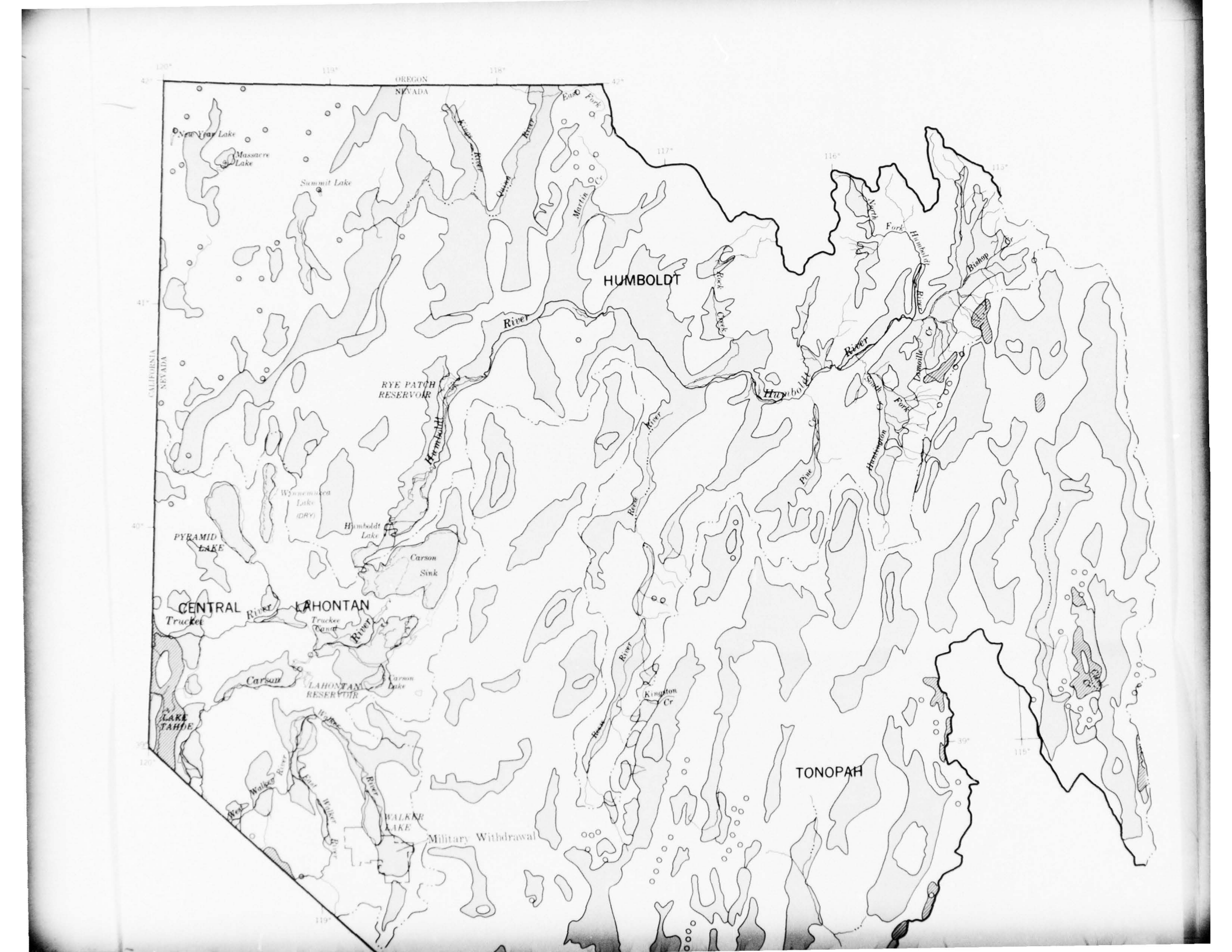
0 25 50 75 MILES

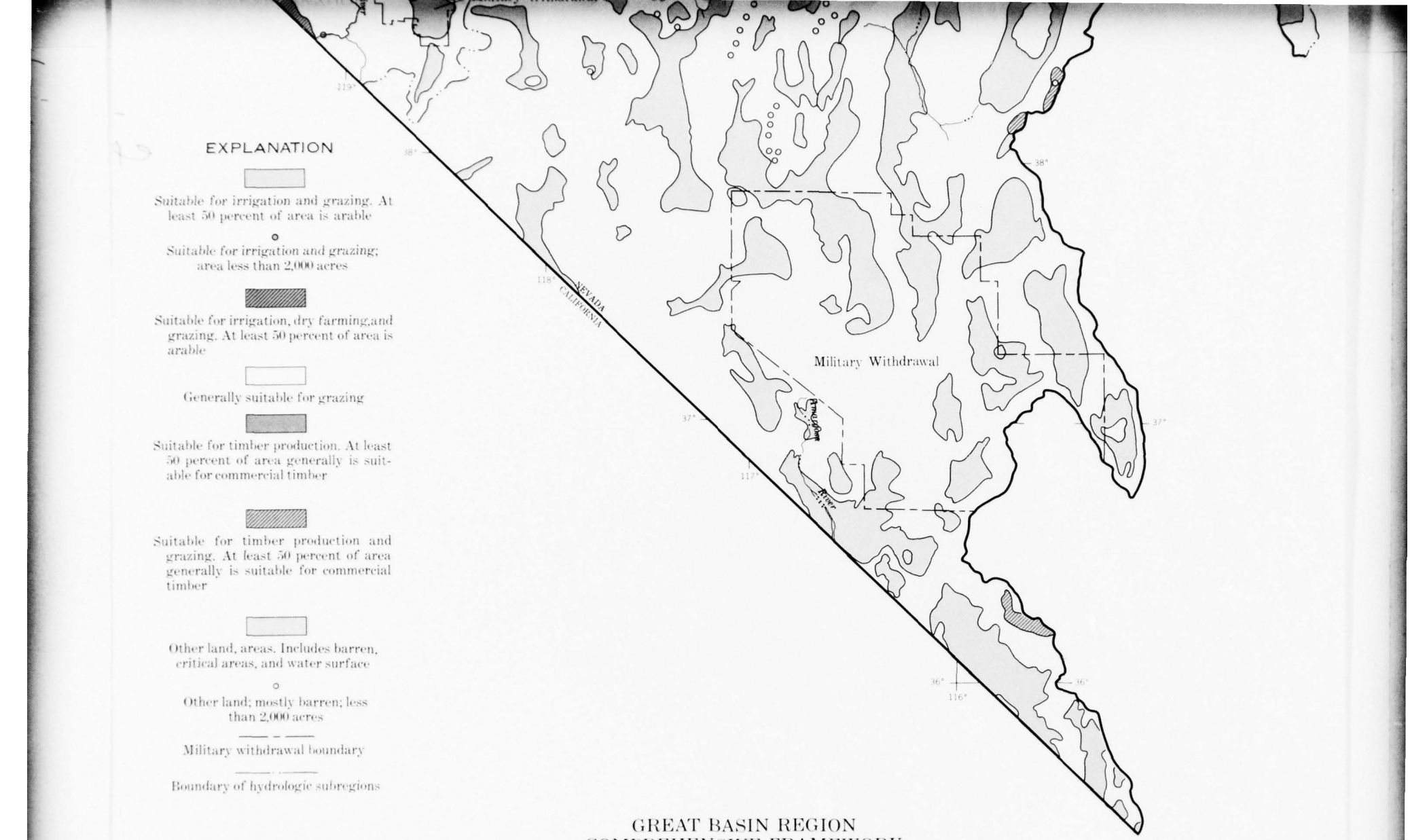
32 MILES TO THE INCH, APPROXIMATELY

1970

LAND SUITABILITY MAP

(FOR FOOD AND FIBER PRODUCTION)


OREGON
NEVADA
CALIFORNIA
NEVADA
New Year Lake
Massacre Lake
Summit Lake
Quinn River
Martin Cr
East Fork
HUMBOLDT
Rock Creek
Humboldt River
North Fork Humboldt River
Bishop Cr
Pumpernickel Cr
South Fork Humboldt River
Huntington Creek
Pine Creek
RYE PATCH RESERVOIR
Humboldt River
Winnemucca Lake (DRY)
Humboldt Lake
PYRAMID LAKE
Carson Sink
CENTRAL LAHONTAN
Truckee River
Truckee Canal
Carson River
LAHONTAN RESERVOIR
Carson Lake
LAKE TAHOE
Walker River
West Walker River
East Walker River
WALKER LAKE
Military Withdrawal
Kingston Cr
Reese River
TONOPAH



GREAT BASIN REGION
COMPREHENSIVE FRAMEWORK
STUDY
(WESTERN SUBREGIONS)

1970

LAND SUITABILITY MAP

(FOR FOOD AND FIBER PRODUCTION)

production is the potential commercial conifer and aspen forest. Grazing land is land with sufficient vegetal cover and with suitable topography to allow grazing. Excluded from grazing are barren areas, timbered areas that are not suitable, and areas too frail to risk damage by this use.

Mineral Resources

The available mineral resources considered here are those that occur in large enough volume or of sufficient value that they are either being exploited at present or have potential of being exploited in the future. "Known resources" are those for which there is considerable tangible evidence of their location and deposition. Some are reserves of which quantity and grade or quality are well established. Others are submarginal at present because of low quality or other factors, but are potentially exploitable within the next 50 years. The "predicted additional resources" are those that are comparable in character to the known resources, but are largely estimated on the basis of geologic premises. These resources are mostly in deposits that are expected to be found within the next few decades. Their exact location is not known, but the geologic environment and broad areas in which they occur is defined and outlined.

There are about 3.3 billion tons of known coal deposits along the eastern boundary of the Region. There are about 45 million tons of vein and replacement deposits which contain mostly lead and zinc with important amounts of copper, gold, and silver. Disseminated low-grade porphyry deposits, containing principally copper and molybdenum with some gold and silver, are about 3 billion tons. Iron deposits amount to about 5 billion tons. Phosphate rock reserves total about 2 billion tons. Gold ores amount to about 50 million tons, barite ores about 100 million tons, and magnesite and brucite 98 million tons. Other important minerals include lithium, tungsten, mercury, uranium, clays, fluorspar, talc, perlite, and gypsum. The Region contains large known and predicted resources of sand and gravel.

The brines of the Great Salt Lake contain large quantities of sodium, chloride, and significant amounts of magnesium, potassium, lithium, and sulfate. Resources beneath the lake are probably large, but estimates are based on scanty information from well data.

Recreation Resources

Most of the Region's vast area is available for recreational purposes in combination with other uses. Over 59 million acres of public land and 8 million acres of private land are suitable and available for outdoor recreation.

About 55,000 acres of public land are available for high density outdoor recreation use, such as swimming pools, playgrounds, marinas, and campgrounds and picnic areas. Over 58 million acres are suitable for recreation in a natural environment and on a multiple use basis. About 742,000 acres are suitable for use as unique natural areas, primitive or wilderness areas, and historic and cultural sites.

The water surface area available and suitable for recreation amounts to 1.5 million acres, including 0.7 million acres in Great Salt Lake. Other prominent natural water bodies include Bear Lake in Utah and Idaho, Utah Lake in Utah, and Pyramid Lake, Walker Lake, and part of Lake Tahoe in Nevada. Many of the reservoirs in the Region are developed for water-based recreation. When new reservoirs are constructed, these will become part of the available supply for recreation.

Fish and Wildlife Resources

Fishing waters are located mainly in or near the Wasatch range and Sierra Nevada. A significant part of the total area of fishable waters is in man-made reservoirs. Fishable waters available in 1965 in the Region are shown in the following tabulation.

Type of water	Streams	Natural lakes	Reservoirs	Small ponds
	(miles)	(acres)	(acres)	(acres)
Cold water	3,700	336,000	43,000	1,900
Warm water	500	12,000	141,000	100
Total	4,200	348,000	184,000	2,000

The present supply exceeds the demand for man-days of angling. The future supply will be decreased if significant fishery waters are eliminated or degraded by pollution, siltation, diversions, channelization, or loss to public access.

The ability of wildlife habitat to produce harvestable supplies of big game, upland game, and waterfowl exceeds present demands. Most of the available hunting opportunity for big game occurs on forest and range lands. Most of the upland game hunting opportunity occurs on cropland. Waterfowl habitat is generally concentrated in large marsh areas. These are the eastern shore of Great Salt Lake in Utah, the terminal reaches of the Carson, Walker, and Humboldt Rivers, and the Ruby Lake area in Nevada.

The availability of future wildlife habitat capacity is dependent on multiple use management with adequate consideration to preservation of suitable areas for this purpose. Wildlife supplies could then be maintained at present levels.

PART VI

PROBLEMS AND NEEDS

Present Problems and Needs - 1965 Base

Water in this Region is in short supply as a cheap, readily available resource. Actually, there is an adequate base supply when both the surface runoff and ground-water storage are considered. The basic concern is the use and control of the most readily available, and economically reasonable segment of this supply. This is dramatically evident by the historic shrinking of the terminal lakes. There are many inefficient uses where improvement could be made. Continuing use and reuse is the major cause of increasing deterioration. At the present time, most irrigated lands do not have a full water supply.

The present needs include storage facilities to regulate water during high flows for release during low flows, and to provide flood control. There is a need for review and revision of water laws, particularly regarding the definition of beneficial use, abandonment or forfeiture of rights which have not been exercised, and appropriation of effluent or waste water. There is a need for additional development of the ground-water potential and a clarification of the State water laws in regard to the mining of ground water. There is a need for improving and maintaining water quality.

The location of irrigable lands in relation to the water supply and the procedures for acquiring public land for private development are problems. Both urbanization and irrigation rely upon their proximity to water for development. The competition for prime agricultural land along the perennial rivers results in land use changes from irrigation to urbanization. This necessitates the development of new lands for irrigation within economical reach of a water supply. Urbanization also increases the problem of flood plain management and flood control. There is a need for statewide land use planning and zoning policies.

There is considerable land abuse through poor management. In areas of sparse rainfall, poor management causes increased erosion and sediment yield. There is need for fire control and improved zoning regulations to protect the land, particularly the frail lands, where the soil mantle is thin or vegetation is difficult to restore. Throughout the Region, particularly near the population centers, more recreational facilities are needed for enjoyment of the land. When proper facilities are provided, there is less tendency for use to become abuse.

The major waterfowl areas in the terminal sinks are vulnerable to damage by upstream water diversions. With proper planning, water development projects can benefit these areas by improving seasonal availability of water.

The decline of the Region's terminal lakes is another major problem. Only in recent years has serious concern been expressed over their decline. They reflect the effect of conversion of water to higher economic use. Presently, about 97,000 acre-feet of water is being supplied from one-time ground-water reserves. About 80,000 acre-feet of this use occurs in the western subregions.

Demands for Water and Related Land Resources

Water Requirements

Withdrawal requirements will increase about 2.3 million acre-feet from 1965 to 2020 and depletions will increase approximately 1.5 million acre-feet during the same period.

Table 8 shows the water requirements by time frames for the eastern and western subregions. The largest increase occurs for municipal and industrial purposes with over 0.7 million acre-feet by 2020, 460 percent over 1965 depletions. Irrigation water requirements increase 0.6 million acre-feet, or 20 percent; and fish and wildlife 0.5 million acre-feet, or 65 percent. The latter is principally for waterfowl habitat. These uses account for over 85 percent of the total increased depletions between 1965 and 2020. About 80 percent of the additional depletions are projected to occur in the eastern subregions.

TABLE 8. PROJECTED WATER REQUIREMENTS

	Great Basin Region				
	1965	1980	2000	2020	Change 1965-2020
			(MAF)		
Withdrawals					
Eastern subregions	5.8	6.1	6.6	7.5	+ 1.7
Western subregions	2.9	3.0	3.3	3.5	+ 0.6
Total	8.7	9.1	9.9	11.0	+ 2.3
Depletions					
Eastern subregions	4.0	4.1	4.5	5.2	+ 1.2
Western subregions	2.0	2.1	2.2	2.3	+ 0.3
Total	6.0	6.2	6.7	7.5	+ 1.5

Land Requirements

Since the land base of the Region cannot be changed, the demands for additional land are actually shifts in land use. Table 9 shows the land use requirements by time frames for major categories. Totals are not shown, as all lands are not included and because of multiple use on most lands.

TABLE 9. PROJECTED LAND USE REQUIREMENTS

	Great Basin Region				
Major use categories	1965	1980	2000	2020	Change 1965-2020
	(1,000 acres)				
Agricultural	68,800	67,900	67,200	66,300	- 2,500
Urban and commercial	1,400	2,000	2,300	2,700	+ 1,300
Recreation and related	2,600	5,200	6,000	6,900	+ 4,300

Reductions in some uses occur to meet increases in other uses. The greatest change in land use is a reduction of 2,400 acres in grazing land to meet other needs. Although total acreage available for grazing would decrease, total production requirements would increase as shown in the following tabulation. The total increase by 2020 is 67 percent of the potential increase that could be obtained.

1965	1980	2000	2020
(Millions of animal unit months)			
4.1	4.3	5.3	5.9

Irrigated cropland requirements show a net increase for developed land of only 6,000 acres from 1965 to 2020. The total new land required during this period is 245,000 acres. Also, 59,000 acres of idle land will be brought into production. This is required to replace 239,000 acres of land converted to other uses, principally to urban and industrial expansion. Table 10 shows the projected shifts in irrigated cropland.

TABLE 10. PROJECTED SHIFTS IN IRRIGATED CROPLAND

	Great Basin Region				
	1965	1980	2000	2020	Change 1965-2020
	(1,000 acres)				
Previously developed land	2,114	2,114	2,104	2,098	-
Loss to other uses[1/]	-	- 65	- 78	- 96	- 239
New land development[1/]	-	55	72	118	+ 245
Net developed land	2,114	2,104	2,098	2,120	+ 6
Idle land remaining	116	122	79	57	+ 59[2/]
Productive land	1,998	1,982	2,019	2,063	+ 65

1/ Values are incremental amounts.
2/ Idle land restored to production.

Timberland acreage would decrease slightly but production on available land would increase from 2.6 million cubic feet to about 24 million cubic feet. Remaining need will continue to be met from *imports*.

Unlike most other resources, minerals can be harvested only once and cannot be replenished. Availability is dependent on discovery and economics, which in turn depend on quality of deposits and technology. Projected regional production, water, and related land needs are the result of a study of national needs, and an assignment of needs to this Region by the United States Bureau of Mines. Thus, the projected needs for water and land for the mineral resources are not based on the OBE-ERS projections.

Watershed Treatment Requirements

The need for adequate watershed protection can be accomplished by applying land treatment and management measures. The following tabulation shows the additional acreages of land requiring protection.

Land resource group	1965-1980	1980-2000	2000-2020	1965-2020
		(1,000 acres)		
Irrigated cropland	348	468	437	1,253
Dry cropland	298	260	265	823
Forest and rangeland	11,720	15,675	9,670	37,065
	12,366	16,403	10,372	39,141

Flood Control Requirements

Risks to life, human suffering, and damage from floodwater are expected to increase as population and economic development increases. The estimated present and future average annual damages, in the absence of future flood control measures, are as follows:

1965	1980	2000	2020
	(Millions of dollars)		
5.3	8.3	14.4	24.3

Complete elimination of flood damages is an unrealistic goal. However, a reasonable degree of flood protection should be provided, consistent with environmental and other resource considerations.

Recreation Requirements

The present and projected recreation demands for the Region are shown by recreation land class and target year in the following tabulation.

	Recreation land classes		
Target year	High density urban	General outdoor	Natural environment 1/
	(Million recreation-days)		
1965	20	34	14
1980	39	62	25
2000	75	116	47
2020	128	193	78

1/ Includes unique natural and primitive classes.

The present and projected land requirements by recreation land class and target year are shown in the following tabulation.

Target year	Recreation land classes: High density urban	General outdoor	Natural environment 1/
		(1,000 acres)	
1965	6	26	7,257
1980	12	48	13,500
2000	23	89	25,000
2020	40	148	42,000

1/ Includes unique natural and primitive classes.

Water surface acreage required to meet water-based recreation demand is shown in the following tabulation.

	1965	1980	2000	2020
			(1,000 acres)	
Eastern subregions	23	43	80	133
Western subregions	18	32	61	95
Total	41	75	141	228

In addition to satisfying quantitative recreation demands, quality should also be considered. This includes preservation of open space, scenic and wilderness areas, wild rivers, historical and cultural artifacts, and unique natural areas, all of which comprise essential aspects of the environment.

Fish and Wildlife Requirements

Fishing demand is expected to increase in direct proportion to population. The present and projected fishing demand is as follows:

Type of fishing	1965	1980	2000	2020
		(1,000 man-days)		
Cold water	1,600	2,000	2,700	3,700
Warm water	200	200	300	300
Total	1,800	2,200	3,000	4,000

Minimum flows in perennial streams are needed to preserve fish habitat. Nonconsumptive water supplies for fish and wildlife resources will become increasingly important to preserve minimum flows in streams throughout the Region. Minimum conservation pools are needed in existing and planned water storage facilities.

Wildlife habitat needs to be maintained and managed. Hunting demands are shown in the following tabulation:

	1965	1980	2000	2020
		(1,000 man-days)		
Big game	640	750	1,020	1,350
Small game	450	550	760	1,050
Waterfowl	220	300	420	600
Total	1,310	1,600	2,200	3,000

Electric Power Requirements

The demand for electrical power capacity would reach 33,000 megawatts by the year 2020, about a 30-fold increase. The energy load will be about 160,000 gigawatt-hours. The following tabulation shows the projected requirements.

	1980	2000	2020
		(Megawatts)	
Capacity			
Eastern subregions	2,600	9,500	24,000
Western subregions	800	3,500	9,000
Total	3,400	13,000	33,000
		(Gigawatt-hours)	
Energy			
Eastern subregions	12,500	47,000	117,000
Western subregions	3,500	16,000	43,000
Total	16,000	63,000	160,000

Water Quality, Pollution Control, and Health Factor Requirements

Additional data, protection, treatment, and surveillance programs are needed to safeguard and maintain the quality of water supplies. Solid wastes and municipal and industrial effluents must be properly disposed of to protect the public health and prevent pollution. Surveillance and enforcement programs are needed to control air pollution, radiological pollution, and disease vectors.

Land treatment measures and improved water management are needed to reduce salt and sediment pollution. This includes low-flow augmentation to reduce total dissolved solids concentration. Better control of fertilizers and pesticides is needed to reduce the amounts of chemical pollution reaching surface waters from irrigated croplands. Accidental spills of liquid wastes and oil must be more closely controlled and programs developed for detection and control to prevent or minimize pollution of streams and land.

Terminal Lakes

The importance of Pyramid and Walker Lakes for recreation, fish and wildlife, and other uses including esthetics, is recognized. The projected needs do not include water to maintain these lakes. Future economic activity requires additional diversions from streams contributing inflow to the lakes which will accelerate the historic rate of decline.

Inflow into Pyramid and Walker Lakes under present conditions is deficient by 200,000 acre-feet per year to maintain present levels. By 2020, 270,000 acre-feet of water would be necessary to maintain these lakes and meet planned upstream uses.

Two alternatives for maintaining these lakes were analyzed to determine the economic impact. The first alternative analyzes the effects of maintaining 1965 inflow. This would stabilize Pyramid Lake at approximately 71,000 surface acres in 259 years and Walker Lake at 22,000 acres in 83 years. The economic impact on the projected OBE-ERS level of development results in the following annual reductions by 2020.

	Total Gross Output (1000 dollars)	Employment (man-years)	Population
Pyramid Lake	3,295,000	62,300	156,000
Walker Lake	266,000	3,000	7,000

The second alternative considered maintaining the lakes at their 1965 year-end level. This alternative has two stages of effects. The first is a result of the immediate reduction in upstream water use to provide sufficient inflow to maintain the 1965 lake levels. The second is the accumulative effect by 2020 of maintaining this reduced use. To analyze the first stage, the adjustment to reduce 1965 uses was made in direct proportion to the uses being made at that time. The economic impacts in 1965 and 2020 in terms of annual reduction at the years indicated are as follows:

		Total Gross Output (1000 dollars)	Employment (man-years)	Population
Pyramid Lake	(1965)	106,000	6,100	14,700
	(2020)	5,898,000	106,000	266,000
Walker Lake	(1965)	6,300	400	950
	(2020)	286,000	3,300	8,300

The Great Basin Input-Output model was used to estimate these economic impacts. The results should be interpreted as an indication of the relative magnitude of the effects which changes in water allocation may cause. Data were not available to analyze the benefits of maintaining these lakes, their contribution to gross regional product or their recreational and esthetic values.

The position of the Secretary of the Interior, with regard to the preservation of Pyramid and Walker Lakes, is that the Department is committed to developing a method of preserving the lakes. This fact is demonstrated by the Pyramid Lake Task Force and its objectives and by other activities of this Department.[1/] The Pyramid Lake Task Force is making several detailed studies regarding ways of providing additional water for Pyramid Lake.

Numerous diking plans have been proposed for management of Great Salt Lake to better utilize residual inflows. Diking schemes could provide stabilized fresh water and saline bays for recreation use and esthetic benefits. The remaining portion of the lake could be used for mineral extraction. Any diking plan would involve legal and economic problems, particularly in regard to existing mineral leases.

1/ Letters of May 17, 1971 and July 22, 1971 from Harrison Loesch, Assistant Secretary of the Interior, to Mr. B. J. Vasey, cochairman of Great Basin Region SFIG, and letter of May 17, 1971 from Harrison Loesch, Assistant Secretary of the Interior, to Mr. Robert D. Stitser, Attorney at Law, Reno, Nevada.

PART VII

DEVELOPMENT PROGRAM

The purpose of this program is to provide a broad guide for the orderly development of water, land, and related resources to meet the projected requirements. It must be recognized that other plans or combinations are also possible. Water is the limiting resource and any upstream development has a direct impact downstream. As this is an area of closed basins, an increase in water use accelerates lowering of terminal lakes and deterioration of water quality. Adequate land is available to meet all future needs. The development program would require shifting of land uses and improved management programs.

Water Development

This discussion does not assume any specific priority of demand. To meet the projected requirements, some sequences of use and reuse are assumed. Water uses requiring high quality water are generally satisfied first and return flows are diverted to other uses requiring water of lower quality. The present undeveloped supply is being consumed by phreatophytes, and by evaporation from wetlands adjacent to streams and terminal sinks. Development consists principally of converting water from one use to another use of higher economic value. Importation of additional water is limited to that quantity presently authorized. Table 11 shows the general sources of supply and diversions to meet the projected water requirements.

TABLE 11. SOURCES OF ADDITIONAL DIVERSIONS BY 2020

				Great Basin Region
Principal use	Stream-flow	Ground water	Imports	Total
		(1,000 acre-feet)		
Municipal and industrial	793	355	231[1/]	1,379
Electric power	65	52	0	117
Recreation	8	16	0	24
Minerals	63	84	0	147
Irrigation	275	111	66	451
Fish and wildlife	156	41	0	197
Total	1,360	659	296	2,315

1/ Based on import alternative in Great Salt Lake Subregion.

Development includes physical facilities and management improvements to increase water use efficiency, and to salvage or divert water from low value to high value use. Irrigation efficiencies are expected to increase about 5 percent between 1965 and 2020. This increased effeciency will meet the supplemental requirements on presently developed cropland and about half the requirements for new cropland. Part of the depletion requirements for waterfowl habitat are met by converting unmanaged wetlands to managed use. Additional diversions are required to supplement the natural supply during periods of shortage. The facilities planned to develop the water supply requirements are shown in table 12.

TABLE 12. FACILITIES PLANNED TO DEVELOP THE REQUIRED WATER SUPPLY

		Great Basin Region			
Facility	Unit	1965-1980	1980-2000	2000-2020	1965-2020
Surface water storage	1000 AF.	1,600	980	700	3,280
Conveyance facilities	miles	225	145	245	615
Pumping plants	number	4	3	9	16
Irrigation laterals	1000 acres	40	30	30	100
Drainage	1000 acres	65	85	75	225
Water treatment	1000 AF.	115	225	275	615
Waste water treatment	1000 AF.	140	240	305	685

About 80 percent of the multiple-purpose storage would be constructed in the eastern subregions principally for streamflow regulation. Nearly all of the canals, tunnels, aqueducts, and pumping plants would be constructed in the eastern subregions.

The increased development for municipal and industrial water occurs principally in the Great Salt Lake and Central Lahontan Subregions. Requirements for the Great Salt Lake Subregion would be met principally from presently developed supplies, imports from the Upper Colorado Region, irrigation conversion, ground water, reuse of municipal return flows, and salvage. During the final time frame additional imports or desalting of brackish water would be required. The Central Lahontan Subregion would utilize surface water with some irrigation water conversion and ground water. Ground water would be the principal source of supply in the other subregions. Treatment of ground water may be required in some localities to meet culinary quality standards. Waste water treatment plants would be developed to treat municipal and industrial return flows.

Additional cooling water requirements for electric power would utilize ground water and some surface water. The greatest demands occur in the Central Lahontan and Humboldt Subregions until the year 2000. Thereafter, major demands are in the Great Salt Lake and Central Lahontan Subregions for nuclear-fired steamplants.

The recreation plan was developed under the concept that people would use the recreational opportunities that are available. Under this concept the resources of the Region are adequate to meet projected demands. Under existing legal, institutional, and financial arrangements, about 45 percent of the demands can be satisfied. Development of water-based recreation facilities would be limited to projects built primarily for other purposes. Water use categorized for recreation is for culinary requirements and is supplied primarily from ground water. There will be conflicts between wild and scenic river requirements and other uses.

Irrigation water requirements are largest in the Bear River Subregion. These would be met almost entirely from surface-water supplies. Diversion requirements for irrigation decrease in the Great Salt Lake and Central Lahontan Subregions due to urbanization of irrigated land. Most high quality irrigation diversions in these areas would be converted to municipal and industrial use. High quality imports into the Sevier Lake Subregion are planned for the 1980-2000 time frame to meet projected demands and upgrade water quality in the lower reaches of Sevier River. In addition, transfers of low quality water from the Great Salt Lake Subregion are planned for the final time frame. These will be replaced by high quality imports or desalting of brackish water. The Humboldt Subregion would rely on additional surface-water and ground-water development supplemented by better management and increased efficiency of use. Increased water requirements in the Tonopah Subregion would be developed from ground-water supplies. Water salvage, ground-water development, quality control, reuse of return flows, and further development of surface-water supplies are planned throughout the Region.

Additional diversions for waterfowl habitat are generally required during late summer and years of below average runoff. Most of the increased diversions would occur in the Great Salt Lake Subregion. These will be supplied principally from low quality return flows. The diversions for waterfowl habitat in the Bear River Subregion are not expected to increase. Better quality water and more efficient use of existing diversions, by providing regulatory storage, are planned. Additional demands for waterfowl habitat in the western part of the Region occur principally in the Humboldt Subregion. These will be met from surface-water return flows supplemented by ground water. Fisheries associated with proposed multiple-purpose reservoirs would satisfy fishing needs. Perennial streams would be maintained and dewatered

segments capable of sustaining a fishery would be restored by low flow augmentation where possible.

Land and Other Development

The land resources generally are adequate to meet the needs. Land requirements for wilderness areas and other types of recreation experiences can be met by utilizing the unique natural areas of the Region. Preservation and rehabilitation of rangelands adaptable for game habitat are essential to maintain sport hunting. Sport hunting programs include land acquisition and development, access roads, and habitat management. Land use changes are expected to continue but competition between specific uses will increase.

The development of irrigated cropland will increase in all subregions by 2020 except the Great Salt Lake and Central Lahontan. Reduced irrigated acreages in these subregions are replaced in other subregions. The greatest demands for additional irrigated land are in the Bear River Subregion where the greatest potential for water development also exists.

Total grazing area is reduced by land use changes. Production from the remaining land would increase by 1.8 million AUMs through range improvement and management practices.

Increases in timber production would be attained by regeneration and stand improvement on 0.7 million acres. The remaining timberland would be placed under intensive management.

The output of metals is expected to increase by almost 50 percent, nonmetals will quadruple, and fuels will increase fivefold. The development of the resources will depend on exploration and development of known deposits. The Region will produce an important share of the Nation's supply of copper, gold, silver, molybdenum, mercury, diatomite and lithium.

Watershed treatment would be applied on 40 million acres of land with about 12 million acres receiving intensive treatment measures. This would significantly reduce sediment pollution. All land treatment needed for the plan would be completed by 2020.

Annual flood damages would be reduced from $24.3 million in 2020 to $7.8 million. These remaining damages will occur mainly in downstream areas because of increased development in the flood plains. Damages in upstream areas will decrease because of planned land treatment measures. The following facilities and measures are associated with the flood control program.

Facility or measure	Unit	1965-1980	1980-2000	2000-2020	1965-2020
Reservoir storage	1000 AF.	580	580	190	1,350
Levees	miles	20	35	45	100
Channels	miles	100	75	35	210
Watershed treatment	1000 acres	230	250	245	725
Flood-plain management	number of areas	6	15	13	34

Electric power requirements would be met by development in the Region and by imports. In the last time frame nuclear plants would replace most imports. The following tabulation shows the projected staging.

Generation	1965	1965-1980	1980-2000	2000-2020	1965-2020
		(Energy in gigawatt-hours)			
In-Region	2,500	3,500	17,000	91,000	111,500
Imports	3,000	7,500	29,500	6,000	43,000
Total	5,500	11,000	46,500	97,000	154,500

PART VIII

PROGRAM IMPLEMENTATION

Implementation of the development program will require that the people involved accept the idea that an overall program is necessary. The first step in comprehending the planning process is an awareness that the various beneficial uses of water and related land are in competition with each other. Successful planning requires that the decision makers have adequate information on the various possible solutions to meet stated objectives. This requires adequate studies and evaluations of reasonable alternatives. There are many alternatives that can provide a variety of solutions. Each has a price, not only in dollars but also in terms of impacts on natural resources, economic resources, and human resources. Therefore, it is necessary to establish general objectives toward which development should be directed.

Implementation of the development program will require integration of the various state water plans with plans of the various Federal agencies involved with water development. Since all state plans are not complete, implementation can be explained in general terms only at this time.

Studies to identify developments to satisfy specific water needs of subregions or specific problem areas should be compatible with a general development program and long-range goals. Comprehensive Framework plans and state plans should be coordinated to point out areas where more intensive study is needed. Coordination of the various levels of planning will insure better utilization of resources. Utah has progressed with statewide planning to the point where intensive studies of known problem areas could now be undertaken. These studies would identify alternative solutions in these problem areas.

Some institutional and legal changes are indicated to allow more complete use of water resources, particularly where opportunities exist for conjunctive use of surface and ground water. Efficient water use suggests changes are also needed in operation and management practices.

Advance planning is necessary to make most effective use of limited resources. With long-range objectives clearly defined, and various alternate solutions evaluated, decision makers can develop a long-range plan for water and related development that will best serve the most people.

Development Program Cost

A summary of estimated costs for the development program is presented in table 13. Costs are shown for water and associated development programs and further divided between Federal and non-Federal expenditures.

TABLE 13. COST SUMMARY FOR DEVELOPMENT PROGRAM

Great Basin Region

	Water development			Associated development			Total development		
	Installation	Operation, maintenance, and replacement		Installation	Operation, maintenance, and replacement		Installation	Operation, maintenance, and replacement	
		Incremental	Cumulative		Incremental	Cumulative		Incremental	Cumulative
	(millions of 1965 constant dollars)								
1965-1980									
Federal	490	7		180	9		670	16	
Non-Federal	320	27		380	37		700	64	
Total program	810	34		560	46		1,370	80	
1980-2000									
Federal	470	8	14	250	11	20	720	19	34
Non-Federal	510	37	65	1,160	110	147	1,670	147	212
Total program	980	45	79	1,410	121	167	2,390	166	246
2000-2020									
Federal	290	6	20	280	16	36	570	22	56
Non-Federal	640	56	121	4,120	231	378	4,760	287	499
Total program	930	62	141	4,400	247	414	5,330	309	555
1965-2020									
Federal	1,240	20		710	36		1,950	56	
Non-Federal	1,480	121		5,660	378		7,140	499	
Total program	2,720	141		6,370	414		9,090	555	

Water development costs include the initial water supply, necessary treatment, conveying it to the point of use, and retreatment prior to reuse. Watershed treatment and flood control costs required to protect or improve the water supply are also included. Associated development costs are for facilities to utilize the water supply, and for programs to improve land use.

Average annual expenditures for "ongoing" water development programs are not shown in the table. These expenditures averaged $25 million Federal funds and $3 million non-Federal funds for the 1965-1969 period. Federal expenditures for associated development averaged $7 million annually but non-Federal expenditures were not determined. The following tabulation shows the future annual expenditures associated with the plan.

	1965-1980	1980-2000	2000-2020	1965-2020
	(Millions of dollars)			
Water development				
Federal	32	23	15	23
Non-Federal	22	26	32	27
Total	54	49	47	50
Associated development				
Federal	12	12	14	13
Non-Federal	25	58	206	103
Total	37	70	220	116

Implementation Details

The Bear River system contains the largest supply of undeveloped water in the Region. Negotiations are now in progress to allocate the unconsumed flows between the States of Wyoming, Idaho, and Utah. Development would be dependent upon compact allocations.

In the Great Salt Lake Subregion, importation of water is necessary to meet immediate needs. This can be accomplished through orderly funding and completion of the Central Utah Project. A decision is needed to determine whether desalting of brackish water or additional imports would best meet the requirements beyond the year 2000. Overall management is necessary to provide maximum utilization of the Great Salt Lake.

The Sevier River is now extensively utilized. Importation of water is necessary to satisfy requirements beyond 1980. Administrative and management procedural changes are necessary to permit water right transfers or exchanges.

In the Central Lahontan Subregion, maintaining Pyramid and Walker Lakes was not considered a use in the development program. If maintaining these lakes is considered a beneficial use of water, two determinations are necessary; at what level the lakes should be maintained, and what uses will be deleted from the program to maintain these levels. The economic impact of maintaining these lakes has been explained under the heading "Terminal Lakes" page 46. A curtailment of the present per capita use of municipal and industrial water is necessary in the Reno-Sparks urban area. This will require either a change in present laws regarding metering or a significant increase in cost under the present system.

Along the Humboldt River, an increased efficiency of water use is required to meet planned agricultural production. Upstream storage on tributaries is a part of the development program in order to better manage the early spring runoff. Ground-water development is planned to meet a large portion of the future needs. It may be necessary to revise present water right laws to require a higher value of beneficial use as a prerequisite to maintaining a water right.

The present pattern of development will probably continue in the Tonopah Subregion. However, an established priority of beneficial use would aid the development program where there is competition between various demands for the limited water supplies.

PART IX

CONCLUSIONS

The Great Basin Region has a variety of resources. Development is needed to beneficially utilize its limited water supply and to properly manage an abundance of high quality land.

The Region resources are capable of meeting OBE-ERS projections, although population growth and increased demands for water and land would increase conflicts between uses. This will have a significant impact on the environment. The development program recognizes and provides for an improved environment although all demands are not met. Present legal and institutional changes are indicated to enhance economic growth and development.

The water resources are sufficient to meet the needs to 2020. Physical availability, quality, location in relation to place of use, priority of need, legal and administrative constraints, and costs, restrict the reasonable availability of the total supply. These limitations indicate augmentation may be more feasible.

All water is presently consumed in some manner although some uses are relatively less valuable than the usual concept of beneficial use. Future demands for water could change the use pattern and require more intensive utilization including reuse. This will lower the quality of surface and ground-water supplies requiring streamflow regulation and treatment of many return flows. The terminal lakes are receding and will continue at an accelerated rate as upstream depletions increase.

Projected agricultural production can be achieved in all time frames. Substantial increases in crop yields per acre are indicated, dependent upon an adequate water supply of good quality, and careful management including better fertilizers and insecticides. There is an abundance of land for all purposes but changes in use are required to meet the needs. Range forage production should increase about 40 percent by 2020 although the total acreage utilized would be less.

Many watershed areas are erosive, unproductive, and in poor condition. Some are classified as frail or critical lands. All these lands can be improved through proper use and management.

Abundant fish and wildlife resources now exist. Increased water and land use will deplete some habitat, but most species are not threatened. Development can offset part of this resource loss.

PART IX CONCLUSIONS

Known and predicted mineral resources are sufficient to maintain the present growth pattern of the industry. Mineral production is associated with national rather than regional needs. This relationship will continue.

Continuing development in flood plains will increase the potential for flood damages. All damages cannot be prevented, but a reasonable level of protection is feasible and should be provided.

There are now large areas of open space and scenic beauty that enhance the environment. Multiple use planning is necessary to maintain and improve this resource. Enforced zoning ordinances beyond the present concept are needed. Population distribution patterns can be changed if incentives are provided.

PART X

RECOMMENDATIONS

A development program for meeting future needs should be adopted. Further study of alternative means of meeting these needs should be made including a comparison of importing additional water in contrast to further development of inbasin supplies.

More detailed studies should be made of the interrelationship of conjunctive use and management of ground-water and surface-water resources. Additional basic data are needed to determine the extent of natural recharge and the possibilities of artificial recharge of ground-water reservoirs. Studies of this type are needed on all major river systems; however, areas of immediate need include Carson Valley, Truckee Meadows, and the Bear River system. The findings of a similar study on the Sevier River system should be implemented and the necessary legal and institutional arrangements made to facilitate this implementation.

Existing phreatophyte areas and playas should be inventoried to determine the possibilities of water salvage. The Walker River system should be studied in detail to determine ways to improve the water quality and maximize the inflow to Walker Lake. The Great Salt Lake should be studied comprehensively to develop an overall management system. This system should: provide functional operating and salinity control, probably by compartmentation; conserve the lake as a viable entity; and provide increased use for mineral production, scenic esthetics, and general recreation use.

Management programs should be established to install the necessary facilities to increase the efficiency of water use, control solid waste disposal, and develop supplemental water for irrigation. These management programs should also consider maintaining minimum streamflows to support fish habitat and water quality needs. Better instrumentation should be developed to monitor streamflow, water and air quality, weather, and soil conditions. Monitoring would provide a basis for stiffer penalties for violators of water and air quality standards.

The flood control program should be used as a general guide for solving the flood problems, utilizing both structural and nonstructural measures.

Broad land use planning policies should be coordinated at all levels and implemented at the lowest level of government consistent with proper management to insure the best use of land resources. This should include zoning, which is essential to regulating development,

and use consistent with the capabilities and limitations of the land. A quantification of the needs for water on Federal lands with due consideration of upstream and downstream uses should be made.

Development of improved plant species, fertilizers, and insecticides that are more compatible with the environment should be continued. Management of Federal lands should be coordinated with private interests to provide the best utilization of all resources such as recreation, grazing, and timber production. More detailed studies, with particular emphasis on obtaining basic data, should be made of all aspects of the recreational needs. This should be incorporated with state planning efforts giving special recognition to the unique natural resources characteristic of this Region with special efforts to preserve these national assets.

Periodic review and updating of the development program should be scheduled and funded to incorporate future trends, additional data, state water plans, and related investigations. The information and experience gained in this effort should be utilized in this continuing program.